THE BRITISH VETERINARY JOURNAL

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Vol. 108 **September, 1952** **No. 9**

EDITORIAL

CALF MORTALITY

If one could make a financial assessment of the wastage which occurs each year in our agricultural economy the figure would be so great that people would be astounded. If they were informed of one tithe of the suffering that is occasioned to livestock by virtue of these losses they would be shocked, and especially so if they knew that a great deal of this loss, wastage and suffering could be prevented. Farmers depend more upon Nature than do other men, and Nature is a capricious mistress. She can be bountiful and bring prosperity, or the reverse. There are times when the debit side is so great that calamity follows. Certain losses and misfortunes which beset the farmer have been so constant in their incidence throughout the centuries that they have been looked upon as inevitable, and unless the loss in any one year rose above a customary or usual level it occasioned little comment.

The above statements apply to all branches of husbandry but they are applicable particularly to that branch which is embraced by the term " animal husbandry."

A similar state of affairs has existed from time immemorial with regard to the human species. A hundred years ago the mortality rate of infants was appalling. The public at large, and indeed the average medical practitioner, looked upon this death rate with equanimity. It was just something to be expected, and there was nothing one could do about it. The parents in their grief were wont to ascribe it to natural or divine law and were solaced by the words: " It is for the best."

(*The August issue of The British Veterinary Journal was published on August* 19)

XUM

It took many years of effort on the part of the few, who could not condone the above attitude, to rouse public opinion to demand that there should be a change in outlook. At last the people's conscience was stirred out of its complacency and real efforts were made to end this evil. Extraordinary results have been achieved—results beyond all previous comprehension. But even to-day one gets a glimpse of the old ideas, for there are some who say that the mortality rate has been reduced to its absolute minimum, a " hard core " beyond which point we cannot pass. In the light of modern knowledge such a conception is just as ridiculous as was that of our forebears a hundred years ago.

We quote this example to demonstrate the success which has attended the forthright efforts to reduce the wastage of human life and to suggest that we know of no legitimate reason why similar results should not follow if a determined attack were made to eliminate wastage of animal life. The well-being of any species of animal depends in great measure upon the care that is bestowed on those that are young. Sentiment alone justifies such care, but in the case of the domesticated animal financial considerations equally demand that waste be eliminated.

Calf mortality is one of the most serious causes of loss affecting the agricultural economy of this country, and the present parlous state of our food supplies—which are derived from animals—is an added incentive to action.

The problem has been approached on previous occasions. Lovell and Hughes[1] examined a series of dead calves in order to ascertain if and what pathogenic organisms were responsible for death. They found that out of 100 calves dying within a few months of birth death could be ascribed to *B. coli* infection in 37 cases. Lovell and Hill[2] approached the subject later on a wider and statistical basis. They confirmed the value of colostrum, the seasonal variation of the losses and the extent of those losses during the first six months of life.

These two research projects emphasised the serious nature of the losses and drew attention to the fact that previous investigations, whilst disclosing most valuable information, had been too narrow in their conception. It was necessary to organise a wider biological study in the field and make an estimate of all the many other factors which might have an influence on health, disease and death. Such a task might be termed " A Study of the Ætiology of Disease in Calves."

The project called for trained workers in the laboratory and in the field. It was vitally necessary that a veterinary surgeon skilled in laboratory techniques should be engaged to work in the field. His job would be the most difficult one. He had to be a man who could gain the confidence and co-operation of the stock-owners. He should be a keen observer and recorder and able to analyse his findings. He should act as a liaison officer between the laboratory workers and the farmer.

These requirements were satisfied and the work was put in hand. It has extended over several years and a most valuable report has been made.

XUM

In this issue we publish the first part of the field officer's report. There is evidence that this worker has been an acute observer and possessed of great persistence and tact.

The Calf Diseases Committee of the Agricultural Research Council deserve our commendation for initiating and sponsoring a most valuable research project.

REFERENCES

(1) Lovell and Hughes (1935): *Jl. Comp. Path., 48,* 267.
(2) Lovell and Hill (1940): *Jl. Dairy Res., 11,* 225.

THE BRITISH VETERINARY ASSOCIATION CONGRESS

THE British Veterinary Association will be holding their Annual Congress from Sunday, September 7, to Saturday, September 13, and this year the choice is Harrogate. This holiday resort is famed for its remarkably pure and bracing air, its fine shops and residences, its open spaces, parks, high-class amusements and entertainments, and last but not least, its proximity to some of Great Britain's most famous and historical buildings, castles, and country mansions.

As a motoring district it is unequalled; the wide roads, the open moors and the exquisite beauty spots in the district provide a fresh run for almost every day for weeks.

The British Veterinary Association and the Congress Committee have gone to great trouble to see that the programme is a good one from the social as well as the scientific point of view. The value of a Congress depends in great measure upon the contacts and friendships that are made, for man does not live by science alone. At Harrogate there is every opportunity for social contact under the most favourable conditions, and it is hoped that all who can possibly manage to be present will do so.

Given good weather, which the Editors of this Journal sincerely hope the delegates will have, it should be a most pleasurable week.

XUM

BRITISH VETERINARY ASSOCIATION

HARROGATE CONGRESS, 1952

Programme

SUNDAY, SEPTEMBER 7

8–10.30 p.m. "At Home," given by the Yorkshire Division, B.V.A., at the Hotel Majestic.

MONDAY, SEPTEMBER 8

10.0 a.m. Civic Welcome by His Worship the Mayor of Harrogate (Councillor A. V. Milton, J.P.) at the Royal Hall.

10.30 a.m. Official Opening of the Exhibition of Surgical Instruments, Drugs, Books, Journals, etc., by the President, B.V.A., in the Royal Hall Annexe.

2.30 p.m. *Address:* "The Activities of the Food and Agriculture Organisation of the United Nations in Matters of Animal Husbandry and the Control of Diseases of Livestock," by Dr. K. V. L. Kesteven, Chief of the Animal Production Branch, F.A.O. Chairman: Mr. J. N. Ritchie, B.SC., M.R.C.V.S., D.V.S.M., Chief Veterinary Officer, Ministry of Agriculture.

8.30 p.m. Civic Reception and Dance given by the Mayor and Mayoress of Harrogate at the Corporation Lounge Hall, Parliament Street.

TUESDAY, SEPTEMBER 9

9.30 a.m. *Paper:* "Technical and Practical Application of Electro-therapy in Equines," by Mr. Norman Gold, M.R.C.V.S., of Redditch. Opener: Dr. A. C. Fraser, B.V.SC., M.R.C.V.S., of Lambourn.

10.15 p.m. Annual Meeting of Ladies' Guild in the Council Chamber, Municipal Buildings.

2.15 p.m. Talk on "Diagnosis of Foot-and-Mouth Disease in the Field," by Mr. A. M. Graham, M.R.C.V.S., Ministry of Agriculture. For B.V.A. Members only. Admission by ticket.

Ladies' Excursion to Fountains Abbey and Ripon Caves, leaving from Royal Hall. Returning 6 p.m. approx.

3.30 p.m. *Paper:* "Electrocardiography in the Horse" (illustrated with lantern slides), by Mr. W. C. Miller, M.R.C.V.S., F.R.S.E., and Lieut.-Colonel J. Hickman, M.R.C.V.S., Animal Health Trust. Time will be allowed for questions.

8.30 p.m. President's Reception and Dance at the Hotel Majestic.

XUM

WEDNESDAY, SEPTEMBER 10

9.30 a.m. *Paper:* "Feline Enteritis," by Dr. A. W. Gledhill, B.A., M.R.C.V.S., National Institute for Medical Research, Mill Hill. Opener: Miss W. M. Brancker, M.R.C.V.S., of Sutton Coldfield.

12 noon Last meeting of 1951-52 Council, B.V.A.

2.30 p.m. Congress Photograph in Royal Hall Gardens.

3.0 p.m. Annual General Meeting, B.V.A.

7.30 p.m. for 8 p.m. Annual Banquet at the Hotel Majestic.

THURSDAY, SEPTEMBER 11

9.30 a.m. *Paper:* "Q Fever (The Domestic Animal as a Source of Infection for Man)," by Dr. G. Slavin, M.R.C.V.S., Senior Research Officer, Ministry of Agriculture, Weybridge. Opener: Dr. H. T. Findlay, Public Health Laboratory Service, Wakefield.

Paper: "*Vibrio fœtus* Infection in Cattle," by Mr. J. R. Lawson, M.R.C.V.S., and Mr. D. J. Mackinnan, B.SC., M.R.C.V.S., Research Officers, Ministry of Agriculture, Weybridge. Opener: Mr. G. Seaton Powley, M.R.C.V.S., of Wetherby.

AFTERNOON: Free for golf, bowls, etc., or:—

2.15 p.m. Congress Excursion to Bolton Abbey.

8.30 p.m. Ladies' Guild Dance at the Hotel Majestic.

FRIDAY, SEPTEMBER 12

9.30 a.m. *Paper:* "Modern Insecticides and Ectoparasite Control," by Mr. W. Downing, F.R.C.V.S., Mr. H. E. Harbour, B.A., M.R.C.V.S., and Mr. L. C. Stones, B.A., M.R.C.V.S., Cooper Technical Bureau. Opener: Mr. I. W. Montgomery, B.V.SC.(Syd.), I.C.I. of Australia and New Zealand.

2.0 p.m. Showing of Cine-films, in colour, of various major operations on small animals prepared by the Royal Veterinary College and Hospital, London, with commentary by Mr. G. C. Knight, F.R.C.V.S. Chairman: Mr. J. O. Powley, M.R.C.V.S.

2.30 p.m. Meeting of the Association of Veterinary Teachers and Research Workers in Council Chambers, Municipal Buildings (opposite Royal Hall).

EVENING: Theatre Party. Details not yet fixed.

SATURDAY, SEPTEMBER 13

10.0 a.m. Closing meeting of the Congress, followed by First Meeting of 1952-53 Council.

N.B.—All meetings will take place in the Royal Hall unless otherwise stated. Enquiries re tickets, badges and for general information should be made by members at the B.V.A. Secretary's Office, Royal Hall (near Annexe entrance).

XUM

MEETING *RE* FOOT-AND-MOUTH DISEASE

Members will note that a meeting on this subject has now been added to the programme at Congress, and will take place on the afternoon of Tuesday, September 9, at 2.15 in the Royal Hall. Please note that this meeting is for members *only*, and *tickets are required for admission*. These are obtainable from headquarters—36, Gordon Square, until September 5; thereafter from the B.V.A. Secretary's Office in the Royal Hall, Harrogate.

GOLF

Anyone wishing to enter the competitions to be played at the Pannal Golf Course on the afternoon of Thursday, September 11, should apply to Mr. J. O. Powley, M.R.C.V.S., 99, Station Parade, Harrogate.

CHILDREN

If any members wish to bring their small children to the Congress, there is a service of "baby sitters" which can be arranged through the Conference Secretary, Royal Hall, Harrogate. The volunteers will undertake to stay with children in their hotel during evenings when their parents may wish to attend various functions. Advance notice is advisable.

THE CONGRESS EXHIBITION

One of the most interesting features of the Annual Congress is the exhibition at which the various firms who supply the profession with instruments, drugs, books, etc., display a representative selection of their products.

The firms go to great trouble and expense to mount this display and members can profit much by spending a few hours amongst the exhibits. The exhibition room is a good place to meet old friends and to make new ones, and we hope that, at this Congress, members will make a point of visiting the show. At some Congresses exhibitors have been hurt by the poor response in attendance. Let us see that this is not the case this year, for a Congress without its customary exhibition would lose much of its attraction.

XUM

GENERAL ARTICLES

MORTALITY RATES AND DISEASE INCIDENCE IN CALVES IN RELATION TO FEEDING, MANAGEMENT AND OTHER ENVIRONMENTAL FACTORS

By F. W. WITHERS

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(This work has been approved for the award of the degree of Ph.D. in the Faculty of Science of the University of London.)

Introduction

1. *General.*

THE work described in this thesis was carried out during the years 1946 to 1949 under the auspices of the Agricultural Research Council. It is a survey of calf disease and mortality in 44 herds in England and Wales and Southern Scotland, and a study of the methods of calf rearing and other factors with a possible relationship to losses. The size of the survey was determined by the number of farms which an observer could visit three or four times annually for the collection of data. Most of the herds were originally chosen in the autumn of 1945 in consultation with the Veterinary Investigation Officers at the following centres: Ayr, Edinburgh, Leeds, Loughborough, Cambridge, Bangor, Newport (Salop), Bristol and Reading, approximately five herds in each area being chosen. A few, for various reasons, were unable to supply information for the whole period, and these were replaced by others. The 44 herds on which the main conclusions are based, supplied data for the three years 1946 to 1948, inclusive, and the total figures for each year relate to the same herds as a continuous record.

No attempt was made to select the herds on a purely statistical basis, as the primary object was an examination of the conditions affecting calf mortality. An endeavour was made to include varying sizes and types, well-managed as well as less efficiently conducted herds, some which had experienced heavy losses of calves in the past and others which had been comparatively free from calf diseases. The willingness of the owners to co-operate in the project was an important factor in selection.

Of the 44 herds studied, 35 were dairy herds and nine beef or dual-purpose to afford a comparison of the different types. They are situated in 26 counties in England and Wales and Southern Scotland. The dairy breeds represented are: Ayrshire, 15; Friesian, 6; Shorthorn, 4; Guernsey, 3; Jersey, 2; and cross and mixed breeds, 5. The beef and dual-purpose breeds include Shorthorn, Aberdeen Angus, Hereford-Lincoln Red Cross, and Welsh Black. The sizes of the herds varied considerably. Judged by the numbers of female cattle over two years old, herd-strengths ranged from under 10 to 450, but most were within the limits of 40 to 100. The average size of the dairy herds was 95 and of the beef and dual-purpose 37, with an average for all of 83. Twenty-eight of them

XUM

were attested herds at the commencement of the investigation and eight others became attested subsequently.

Records were kept of all calves born (including still-births and abortions) from January 1, 1946, to December 31, 1948, with their subsequent histories up to six months of age. The data was compiled on record cards—a Farm Card giving general information for each herd and an Individual Card for each calf. Copies of these cards are reproduced in Appendix 6. As far as could be arranged, post-mortem examinations of casualties were carried out by Veterinary Investigation Officers and private veterinary surgeons were consulted regarding sickness among calves which they had treated.

The data collected from January 1 to October 31, 1946, have been placed at my disposal and are incorporated in my personal observations from November 1, 1946, to the end of the investigation. I am responsible for the compilation of all the statistical results of the survey and for the study of the factors concerned in calf mortality and disease which are the subjects of this thesis.

To extend the scope of the enquiry to areas not covered by the main investigation, certain additional farms were visited from time to time in Kirkcudbrightshire, in Devon and Cornwall, and in Lincolnshire for the collection of information of a general nature on calf-rearing methods and mortality. An account of the results of these visits is given in Section III, 13, of this thesis.

2. Short account of previous work.

The information available concerning mortality and disease incidence in calves in Great Britain is limited. Jordan, reporting an investigation covering 26 farms in Ayrshire in 1931-32 recorded a mortality among heifer calves of nearly 22 per cent " within a comparatively short time." Smith showed a death rate of 20 per cent among heifer calves in the same county during the years 1931-34. They dealt only with heifer calves, as the bulls are mostly disposed of within a few days of birth. They noted a pronounced seasonal swing in the incidence of calf mortality. Jordan recorded rates of 27 per cent and 24 per cent for those born in the spring of 1931 and 1932, respectively, compared with only 8 per cent for calves born in the autumn. Smith similarly found spring and autumn mortality rates of 25 per cent and 8 per cent.

The only extensive enquiry is that of Lovell and Bradford Hill, which covered 335 well-distributed herds in England and Wales and 47 in a limited area of Scotland during the years 1936 and 1937. They recorded mortality rates, for calves up to six months of age, of 4.4 per cent and 5.5 per cent for bull and heifer calves respectively in England and Wales, and of 4 per cent and 11.4 per cent for the two sexes in Scotland. They also collected information on pre-natal losses, and found that still-births and abortions accounted for 9.9 per cent of total births in England and Wales and for 7.9 per cent in Scotland. The total losses recorded in this investigation, pre- and post-natal up to six months of age, were 14.3 per hundred pregnancies for the herds in England and Wales and 15.1 for those in Scotland, indicating that one pregnancy in seven fails to produce a calf six months old. The seasonal variation

in deaths was not examined in a precise manner by these authors, but they demonstrated a similar tendency to that observed by Jordan and Smith. In Scotland the 1937 rates for female calves were 12.2 per cent for the first half of the year and 3.7 per cent in the second half; and in England and Wales the combined figures for the two years gave the heifer calf mortalities in the first and second halves of the year as 6.2 and 5 per cent, respectively. It was concluded that " factors inimical to calf life have a greater influence in the first two quarters of the year, chiefly, it seems, in the first quarter, and that . . . their effect is more pronounced in Scotland than in England and Wales." With regard to the relation of methods of feeding to the mortality rates observed, it was found that the rates rose for both sexes in passing from the group of herds allowed colostrum naturally to those given it by bucket, and, finally, to those from which it was withheld, and it was suggested that there is an advantage in allowing the calf to take colostrum naturally from its mother. The subsequent methods of feeding adopted, viz., suckling, bucket feeding with whole milk and with diluted milk did not appear to influence mortality, neither did the giving or withholding of water. In this survey no reliable figures regarding the causes of death were collected, but a large number were stated to have died from white scours, and in view of earlier work this was accepted. The authors stated that they regarded white scours or *coli-bacillosis* as an important hazard of the first week or fortnight of the calf's life. Nearly half the deaths of heifer calves took place in the first week of life, 61 per cent within the first two weeks, and rather more than three-quarters in the first month, indicating the very early ages at which the bulk of post-natal loss occurs.

A calf mortality survey of 84 self-contained herds in Dumfriesshire was carried out by Hector and Rowat during the six months November, 1946, to April, 1947, inclusive. They found a mortality among heifer calves of 6.8 per cent up to 60 days of age. This was lower than they expected, and it was pointed out that the herds were probably of a higher standard of management than the average. The loss due to still-births was 2.46 per cent of the total births, a figure very close to that given by Lovell and Bradford Hill for Scotland (2.9 per cent), but no mention is made of abortions, which were apparently omitted. The highest mortality rates were found to occur in February and March, with April a close second. The desirability of feeding colostrum to calves appeared to be generally recognised, but it is not stated whether it was fed by bucket in all herds. In view of the general practice in Southern Scotland, and as it was stated that the amounts fed varied considerably, it is to be assumed that it was bucket fed in all cases. A great variation in the amount of milk subsequently fed to calves in different herds was noted, but these workers were unable to correlate the mortality rates to this or to other differences in feeding methods. The greatest number of deaths of calves of both sexes occurred during the first five days, but for heifer calves only most deaths fell in the six to 10 days age-group. No arrangements were made in this survey for veterinary diagnoses of the causes of deaths, but in the majority of cases an indication was given by the owner. A feature was the large proportion (over 35 per cent)

XUM

due to miscellaneous causes, but this was probably due to lack of accurate information. Other causes mentioned are weakness at birth, white scours, *Bact. coli* septicæmia, pneumonia and joint-ill. The total deaths were only 76, so that the incidence of the various conditions, based on lay diagnoses, are not of great value.

Information on the causes of deaths in young calves and the ages at death is given by Lovell and Hughes in an account of the bacteriological examination of one hundred cases in 1935. These were obtained from a wide area in Great Britain. *Bacterium coli* was isolated alone or in mixed culture from 43 per cent and *Corynebacterium pyogenes* in pure or mixed culture from 17 per cent of this series. There were 37 cases of pure *Bact. coli* infection, and of these 22 died within the first week and 11 during the second week of life. All 37 died at between 24 hours and 16 days old. Twelve cases of pure *C. pyogenes* infection were recorded, and of these the ages at death of 11 ranged from seven days to five and a half months. Of this series of 100 cases, 25 were less than seven days old at death and 28 were from seven to 14 days old. There may be an excess of deaths in the second week compared with the first in this record, owing to the inclusion of calves bought for a nutrition experiment.

In general the work of previous investigators has indicated that both pre-natal and post-natal losses among calves are serious, and may result on the average in one pregnancy in six or seven failing to produce a living calf six months old. The early disposal of the majority of bull calves in dairy herds has been noted by earlier authors who have either confined their calculations of death rates to heifer calves or observed that the lower rates found in bulls were fictitious owing to the number sent to slaughter. This artificial depression of the male death rate when based on total deaths expressed as a percentage of total births is likely to be even greater in Scotland than in England and Wales owing to the custom of earlier disposal. There appears to be a marked seasonal variation in mortality, the greatest losses occurring in the spring months. Post-natal losses are greater in Scotland than in England and Wales, but it has not been demonstrated that geographical location appears otherwise to exercise any direct influence apart from the possibility of a slight increase from south to north, as suggested by Lovell and Bradford Hill. The feeding of colostrum is recognised as an important protective factor, and it is suggested that there may be an advantage in allowing the newborn calf to take it naturally. No direct correlation between mortality and feeding methods or other factors in the general husbandry has been established. There is agreement that the majority of deaths occur at an early age, probably within the first week or 10 days, and that the commonest single cause appears to be *Bacterium coli* infection.

Results of Survey

I. Total Data.

The general statistical results of the survey are given in Table 1, which is arranged so that the figures can be compared with those of Lovell and Bradford Hill in their Table 2.

In the 44 herds from which information was recorded during the three years there were 9,327 births, of which 8,720 calves were born alive. In addition, 61 were bought to rear in some of the herds, a total of 8,781 live calves. Of these, 469 died before attaining the age of six months, an over-all mortality rate of 5.34 per cent. This is lower than would be the case if bull calves were not disposed of in the dairy herds. For this reason also the rates for bull calves are considerably lower than those for heifers, as they are calculated on the basis of the total live births. The male rate is also much lower in England and Wales than in Scotland, although the two rates were about the same in the earlier survey. As the male mortality rate is artificially depressed in each case owing to early disposals, this is not of great importance. This will be discussed more fully in a later section. The heifer rates for England and Wales and for Scotland are in close agreement with those in the 1936-37 survey, viz., 6 per cent, compared with 5.5 per cent for England and Wales, and 11.1 per cent, compared with 11.4 per cent for Scotland.

In Table 1 the figures for abortions and still-births are combined, and the losses on this account are practically the same for England and Wales and for Scotland. The sub-division of the figures into still-births and abortions will be considered in detail in the next section. Here it may be noted that the pre-natal loss for all herds for the three years is 6.5 per cent, compared with 9.7 per cent in 1936-37 in the previous survey.

The rates of total loss, viz., 10.3 per cent for England and Wales and 14.5 per cent for Scotland, are 4 and 0.6 per cent lower, respectively, than the earlier results. These differences are mainly accounted for by the reduced incidence of pre-natal loss, but the reduction is much greater in the herds in England and Wales (14.3 to 10.3 per cent), than in those in Scotland (15.1 to 14.5 per cent).

II. Pre-natal Losses.

1. *General.*

In the present survey still-births and abortions accounted for no fewer than 56.4 per cent of the total losses. They thus constitute a serious loss to the livestock industry, greater than that due to deaths of live-born calves up to six months of age.

In a survey of this nature, where statistics are collected at periodical visits, it is not possible to classify pre-natal losses on a strictly scientific basis. There are great variations in the interpretation of the terms, " abortion," " still-birth," and " premature birth," and without reliable information and precise definitions the data are of no value. It was decided to apply the following definitions as far as practicable :—

(*a*) A fœtus or calf born dead up to seven months from the date of service is counted as an abortion.

(*b*) If the period of gestation exceeds seven months and the calf is born dead :—

(i) It is counted as an abortion if the history suggests a pathological

TABLE 1

Total data—44 herds—England and Wales and South Scotland.

	1946		1947		1948		Three-year period, 1946, 1947 and 1948 England and Wales		Scotland		Great Britain	
	M	F	M	F	M	F	M	F	M	F	M	F
Live-born calves	1,481	1,374	1,376	1,445	1,527	1,517	3,193	3,164	1,191	1,172	4,384	4,336
Calves bought to rear ...	2	26	4	11	11	7	17	44	—	—	17	44
Calves at risk	1,483	1,400	1,380	1,456	1,538	1,524	3,210	3,208	1,191	1,172	4,401	4,380
Died up to 6 months of age ...	46	93	51	129	50	100	71	192	76	130	147	322
Mortality per 100 at risk ...	3.1	6.6	3.7	8.9	3.3	6.6	2.2	6.0	6.4	11.1	3.3	7.4
Born dead, i.e., aborted and still-born	230		200		177		446		161		607	
Total births	3,085		3,021		3,221		6,803		2,524		9,327	
Born dead per 100 total births	7.5		6.6		5.5		6.6		6.4		6.5	
Total losses, i.e., born dead and died up to 6 months old	369		380		327		709		367		1,076	
Total births and bought ...	3,113		3,036		3,239		6,864		2,524		9,388	
Total losses per 100 total births and bought ...	11.9		12.5		10.1		10.3		14.5		11.5	

M = male. F = female.

condition, or a blood test or other examination is positive for *Brucella abortus* or other organism associated with infectious abortion.

(ii) It is counted as a still-birth if there is no such history and/or a test is negative; the suffix "premature" is added if the gestation period is less than 280 days.

Based on these definitions the classification of the calves born dead is given in Table 2.

TABLE 2

Classification of calves born dead.

	Abortions			Still-births			Totals			
	M	F	SNR	M	F	SNR	M	F	SNR	
1946 ...	8	6	26	112	63	15	120	69	41	230
1947 ...	9	4	27	90	53	17	99	57	44	200
1948 ...	8	8	15	86	52	8	94	60	23	177
	25	18	68	288	168	40	313	186	108	607
	111			496			607			

M, male; F, female; SNR, sex not recorded.

The abortions form 1.2 per cent of the total births and 18.3 per cent of the born dead. The still-births constitute 5.3 per cent of total births and 81.7 per cent of the born dead. It is likely that owing to incomplete information, the number of abortions here given is an underestimate.

The figures collected by Lovell and Bradford Hill were based on information supplied to official milk recorders by the owners of herds and were not subject to any precise definitions. It is therefore best to confine a comparison to the combined pre-natal losses. Their figure for all herds was 9.7 per cent and this may be compared with the present rate of 6.5 per cent.

Reference to Table 1 shows that this is the mean of the rates for the three years, viz.: 1946, 7.5 per cent; 1947, 6.6 per cent; and 1948, 5.5 per cent. It appears that in the past thirteen years (1936 to 1948, inclusive) there has been a fall of 4.2 per cent in the pre-natal loss, of which half occurred in the past three years. Nearly all the herds in this survey have used protective vaccination against contagious abortion (most of them Strain 19) for a number of years. The control measures adopted and the practice of vaccination during the past decade may have brought about this favourable result.

Of the 607 calves born dead, 51.6 per cent were males, 30.6 per cent females, and of the remainder (17.8 per cent) the sex was not recorded.

The gestation periods of these calvings are given in Table 3.

XUM

TABLE 3

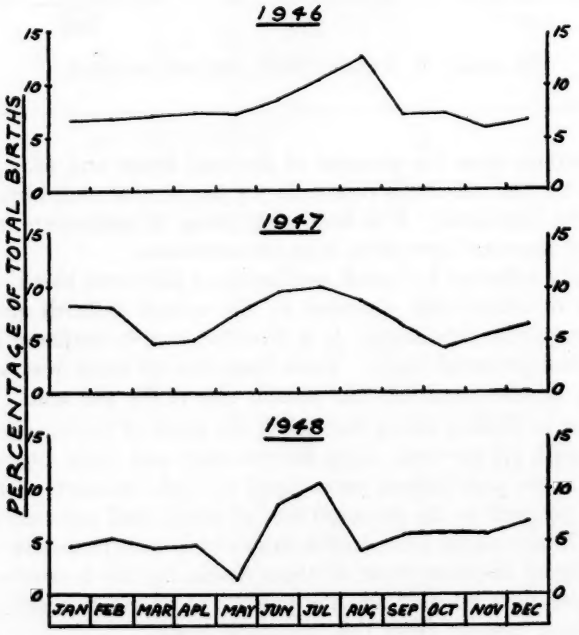
Gestation periods of pregnancies resulting in abortions and still-births.

	Gestation period : months								
	—4	—5	—6	—7	—8	—9	Full-time	Not known	Total
1946 ...	1	2	11	17	8	29	61	101	230
1947 ...	4	6	10	6	15	24	58	77	200
1948 ...	3	2	8	14	13	23	55	59	177
	8	10	29	37	36	76	174	237	607

The 111 abortions comprised the first four groups (84), 18 of seven to eight months, four of eight to nine months, and five the gestation period of which was unknown. Most of the 237 in the last category were first calvings, the service dates of which were not recorded.

FIGURE 1.

MONTHLY INCIDENCES OF PRE-NATAL LOSSES.



2. *Seasonal Incidence.*

The monthly incidences of the pre-natal losses are given in Table 4 and are shown graphically in Figure 1.

TABLE 4

Monthly incidences of pre-natal losses.

	1946			1947			1948		
	Total births	Born dead	*	Total births	Born dead	*	Total births	Born dead	*
January ...	259	17	6.6	281	23	8.2	307	14	4.6
February ...	293	20	6.8	299	24	8.0	326	17	5.2
March ...	311	22	7.1	314	15	4.8	340	15	4.4
April	237	17	7.2	219	11	5.0	227	11	4.8
May	183	13	7.1	163	12	7.4	150	2	1.3
June	140	12	8.6	158	15	9.5	147	12	8.2
July	144	15	10.4	140	14	10.0	155	16	10.3
August ...	188	24	12.8	191	17	8.9	197	8	4.1
September ...	310	22	7.1	305	19	6.2	370	21	5.7
October ...	444	31	7.2	379	16	4.2	366	21	5.8
November ...	266	16	6.0	301	16	5.3	319	18	5.7
December ...	310	21	6.8	271	18	6.6	317	22	7.0
	3,085	230	7.5	3,021	200	6.6	3,221	177	5.5

* Incidence per cent.

The highest incidences occurred in June, July and August in 1946 and 1947, and in June and July, 1948. Generally speaking these are the months in which there are the fewest calvings. It is probable that most of the cows and heifers that abort or give birth to premature dead calves in the summer months were served in December and January for autumn calving. It is generally considered that this is more favourable than spring calving owing to the dams being at grass during the latter months of pregnancy. This points to the possibility that these summer abortions and still-births may be determined quite early in pregnancy when conditions of climate and nutrition are most favourable. It may also be noted that the natural time of service is late summer for calving in May, and although this involves winter pregnancy, natural conditions of life would prevail and pregnancies do not commence in the middle of winter.

3. *Pre-natal Mortality of First and Subsequent Calves.*

The numbers and proportions of first and subsequent calves among the total births and the aborted and still-born are given in Table 5. The abortion and still-birth incidence (i.e., the born dead as a percentage of total births) is shown in the last column.

First calves form a considerably larger proportion (39.0 per cent) of the born dead than of total births (30.4 per cent). The incidence of still-births and abortions among first calves is 8.4 per cent, compared with lower incidences for second to seventh calves, which are fairly uniform. From the eighth calvings the numbers are probably too few to be relied upon.

TABLE 5

Data for pre-natal losses in first and subsequent calves.

	Total births		Born dead		
	No.	Proportion %	No.	Proportion %	Incidence* %
First calves ...	2,838	30.4	237	39.0	8.4
Second calves ...	2,081	22.3	119	19.6	5.7
Third calves ...	1,485	15.9	90	14.8	6.1
Fourth calves ...	1,032	11.1	51	8.4	4.9
Fifth calves ...	710	7.6	40	6.6	5.6
Sixth calves ...	464	5.0	22	3.6	4.7
Seventh calves ...	290	3.1	15	2.5	5.2
Eighth calves ...	144	1.5	11	1.8	7.6
Ninth calves ...	62	0.7	7	1.2	11.3
Tenth calves ...	25	0.3	1	0.2	4.0
Over tenth calves ...	12	0.1	1	0.2	8.3
Not known ...	184	2.0	13	2.1	7.1
	9,327	100.0	607	100.0	6.5

* Born dead as a percentage of total births.

It will be seen later that this greater incidence in first calves is not the case with post-natal deaths. The greater proportion born dead is in accordance with the general experience that the hazard of first calving is greater than that of subsequent parturitions and frequently results in dead calves due to dystocia. Abnormally large male calves are often the cause of such difficulties.

4. *Abnormal Still-born Calves.*

A few of the calves born dead (2.6 per cent) were abnormal. The abnormalities comprised:—

Bull-dog calves	2
Anasarcous calves	11
Calves with "undershot" jaw	3

(In addition, three bull-dog calves and three with "undershot" jaw were born alive.)

The bull-dog calves appeared to be of the classical type. The anasarcous calves, several of which were examined by the Veterinary Investigation Officer, were described as typical and without skeletal abnormalities. In some of them there were small ear appendages, each a plaque of skin on a thin stem. In those described as "undershot" the mandible showed marked under-development, giving a "fish-head" appearance. There was a unilateral blindness in one of these cases.

These abnormalities were confined to four herds, three Ayrshire and one Dairy Shorthorn. In two of these (Ayrshire) the incidence of still-births and abortions has been very small and the bull-dog calves were the first recorded. In one of them two other still-born calves were dropsical and three bull-dog calves were born alive. No explanation could be found for these cases. In one herd the abnormal calves were by three different sires and the other was a solitary case.

In the remaining two herds, however, the trouble is more serious. In both there has been a greater incidence of abortions and still-births than the average (9.7 and 10.3 per cent, compared with the average for all herds of 6.5 per cent). In one (Ayrshire) there have been nine œdematous calves, five of them sired by one bull. It is reported that the majority of such calves in this herd result from matings of this bull with the female progeny of another bull since disposed of. In the second herd (Dairy Shorthorn) the abnormal calves have had undershot jaws, and the trouble commenced in 1947. There have been six cases in the herd, three still-born and three born alive. The third and fourth calves (one alive and one born dead) of one cow were both undershot and a heifer produced a living undershot calf at first calving and aborted a 3½-months fœtus 11 months later. These abnormal calves were all by one sire. In the same herd in 1946, of 10 calves born dead, eight were first calves sired by one bull (not the one that sired the undershot calves). These were all large, full-time calves; calving was delayed and needed assistance, but none were abnormal.

There is clearly need for more detailed investigation of such cases with regard to the hereditary and other factors involved in the production of such abnormalities. Whether there is anything in common between these three types of abnormality is not known.

The occurrence of bull-dog calves in the Dexter breed is classical (Seligman, 1904; Crewe, 1923), but cases in a Friesian herd have recently been reported (Berger and Innes, 1948). Jamieson, Simpson and Russell (1945) reported œdematous distension of the head, neck and forelimbs in 11 of 13 successive calves born dead or moribund in an Ayrshire herd. In two of these the fresh thyroids were examined and found to be deficient in iodine content. Mention of the anasarcous condition in the bull calves of a group of heifers, the female calves of which were all normal, is made in the *Veterinary Record* (1947). These heifers were the progeny of one bull.

The undershot condition of the jaw in calves does not appear to have been recorded.

III. Post-natal Mortality and Sickness

1. *Death Rates in Dairy Herds and in Beef and Dual-purpose Herds.*

Dairy Herds: Bull Calves.

The number of bull calves born alive and purchased to rear in the 35 dairy herds during the three years was 3,993. Of these, 127 (or 3.2 per cent) died up to the age of six months. It has already been pointed out that this is not an accurate indication of the mortality owing to the early disposal of nearly 90 per cent. The number sold within a week or so was 3,612 and if these are deducted, the deaths would amount to 33.3 per cent of the 381 remaining. In the first case the deaths are spread over the total live births, a large majority of which are not at risk beyond a week or so, and in the other the same number of deaths is assumed to occur among the small number retained to rear, although many die that would have been disposed of if they had survived.

It is obvious that the true male mortality rate lies between these two

XUM

extremes, the mean of which is about 18 per cent. The nearest approximation can be made by taking a number of herds in which a fair proportion of the bulls are retained and, after deducting those sold, to assume that the remainder would be reared and to count the deaths against these. In five such herds in England the mortality of 99 bull calves was 17.2 per cent, and in three herds in Scotland the rate for 146 calves was 31.5 per cent. Possibly these are over-estimates, but they are an indication. If the true male mortality in dairy herds bore the same relation to the heifer rates as it does in the beef and dual-purpose herds the figures would be 9.5 per cent for England and Wales, and 16.7 per cent for Scotland. It may perhaps be assumed that the true rates lie between these two indications—that is, approximately 13 per cent for England and Wales, and 24 per cent for Scotland.

Dairy Herds: Heifer Calves.

Accurate assessment of the heifer mortality presents no difficulty. Very few are disposed of, those sold usually being twins to bulls or not considered worth rearing. All heifers disposed of before reaching the age of six months have been eliminated from these calculations.

The number born alive and purchased in the dairy herds was 4,053, of which 309 were sold. Table 6 gives the mortality statistics relating to those kept to rear.

These rates for England and Wales, Scotland and Great Britain are somewhat in excess of the heifer mortality rates shown in Table 1 for all herds, viz., 6.8, 11.9 and 8.3 per cent, compared with 6.0, 11.1 and 7.4 per cent respectively. This is due to the effect of the lower rates in the beef and dual-purpose herds (which are included in Table 1) and to the omission of the heifer calves sold from Table 6.

The Scottish rate is considerably higher than that for England and Wales,

TABLE 6

Heifer calf mortality in 35 dairy herds, 1946-48.

	England and Wales	Scotland	Total
1946			
Calves attempted to rear ...	849	363	1,212
Died up to six months ...	42	47	89
Mortality per cent	4.9	12.9	7.3
1947			
Calves attempted to rear ...	898	350	1,248
Died up to six months ...	79	44	123
Mortality per cent	8.8	12.6	9.9
1948			
Calves attempted to rear ...	916	368	1,284
Died up to six months ...	60	38	98
Mortality per cent	6.6	10.3	7.6
1946-48 inclusive			
Calves attempted to rear ...	2,663	1,081	3,744
Died up to six months ...	181	129	310
Mortality per cent	6.8	11.9	8.3

and the difference is of the same order as that found by Lovell and Bradford Hill. Their rate for Scotland was just over double that for England and Wales; the rate above is 75 per cent greater. The difference was much more marked in 1946 than in the other years. In 1947 the mortality was on an average higher (possibly to some extent due to climatic conditions), but in that year it fell slightly compared with 1946 in the Scottish herds. The latter show an improvement in the mortality during the three years, but the rate for England and Wales had not recovered its 1946 level in 1948.

Beef and Dual-purpose Herds.

The live calves, including a few that were purchased at under a week old, numbered 735 in these nine herds. Of these, 38 were sold at less than six months old. Table 7 shows the mortality rates for bull and heifer calves in this group of herds.

TABLE 7

Calf mortality in 9 beef and dual-purpose herds, 1946-48.

	Males	Females	Total
1946			
Calves attempted to rear	148	121	269
Died up to six months	7	4	11
Mortality per cent	4.7	3.3	4.1
1947			
Calves attempted to rear	113	103	216
Died up to six months	7	6	13
Mortality per cent	6.2	5.8	6.0
1948			
Calves attempted to rear	121	91	212
Died up to six months	6	2	8
Mortality per cent	5.0	2.2	3.8
1946-48 inclusive			
Calves attempted to rear	382	315	697
Died up to six months	20	12	32
Mortality per cent	5.2	3.8	4.6

The male rate is higher than the female in each year, but this is least marked in 1947, the year in which the mortality was greatest as a whole. The female rate is, on the average, less than half that in the dairy herds. This difference is again less marked in 1947 than in the other years.

Sixty-one per cent of the calves in these herds were in three beef herds in which suckling on the dams in yards or at grass for six months or more is the practice. Twenty-one per cent were in two dual-purpose herds in which calves suckle *ad libitum* for several days and are subsequently bucket-fed. The remainder (18 per cent) were in four very small dual-purpose herds where calves are reared on the bucket from birth but great care is taken to see that they receive the milk of their dams for three to five weeks.

The much lower rates of mortality in these herds compared with dairy herds are clearly due to the more natural conditions of rearing.

2. *Seasonal Incidence of Deaths.*

Casual examination of the deaths recorded in this survey points to the early months of the year as those with the highest mortality. Closer scrutiny shows that over 40 per cent of the total deaths occurred in the months of February, March and April.

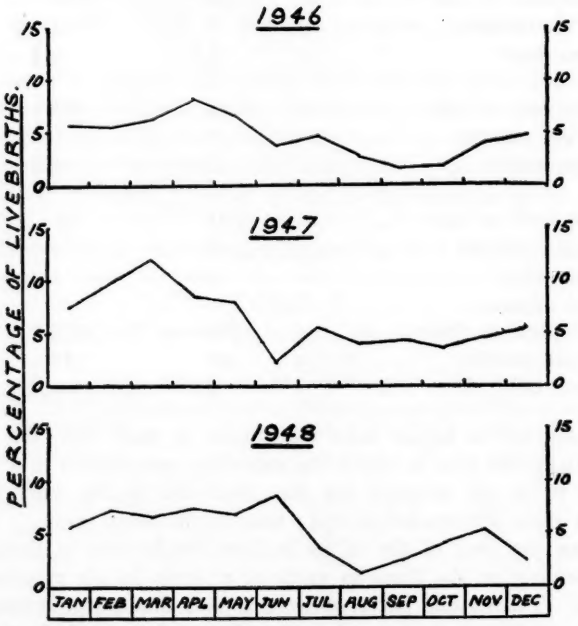
TABLE 8

Proportion of annual deaths which occurred in the months of February, March and April.

1946	Percentage of the year's deaths
1946, February to April inclusive	39·5
1947, February to April inclusive	44·8
1948, February to April inclusive	40·0

ALL HERDS: MALE & FEMALE CALVES. MONTHLY INCIDENCES OF DEATHS UP TO 6 MONTHS OLD.

FIGURE 2.



All Herds: Male and Female Calves.

Table 9 (in October, 1952) shows the calves born alive and the numbers that died in each month up to one month and to six months of age, and the monthly incidences. The monthly incidences of deaths up to six months old are also shown graphically in Fig. 2.

(To be continued)

THE EXMOOR PONY—AND A SURVEY OF THE EVOLUTION OF HORSES IN BRITAIN

By J. G. SPEED, M.R.C.V.S., and M. G. ETHERINGTON

PART I

Exmoor Ponies

THE ponies of Exmoor are a race of small horses whose habitat has been the high, wild plateaux of Exmoor in Somerset for as long as history has record. The attention of zoologists has often been drawn to them because of their uniformity of size and colouring, and because of the isolation in which they have been kept. Professor Alfred Nehring in Berlin used an Exmoor pony as a type animal in his comparisons of German fossil horses in 1884, and so also did Professor Cossar Ewart in Edinburgh, in his Penicuik experiments on the multiple origin of horses.

The " Forest of Exmoor " was from earliest history and until comparatively recently—about 1819—a Crown forest and a reserve for beasts of the chase, and the ponies, as well as the red deer, were preserved in it.

The ponies themselves, in addition to possessing indefinable characteristics of the wild animal, the weather wisdom, the alert shyness, the instinctive ability to adapt themselves to methods of obtaining food in difficult circumstances, and their obedience to somewhat complex herd laws, have more obvious features which may be examined in detail, and in the true, primitive herds which have been saved, the animals show such surprising uniformity that the description of one individual will serve for all others of its age and sex.

A herd of such ponies presents an appearance which at once arrests the attention of the field naturalist and arouses his curiosity. The impression he gains is similar to that given by a herd of the only other large wild mammals still surviving in Britain, the red deer. Should his curiosity prompt him to follow and study such a herd he may find the same difficulties in keeping the ponies under observation as he does with the deer, but the study will well repay him. His impressions are likely to be that the behaviour of the herd shows such clear indications of an established system that he is driven to the conclusion that this is no heterogeneous collection of tame animals, but a community of individuals with a common inherited experience. Although as far as we know there is no written account of the sociology of horses, on Exmoor there is one clearly defined race, the individuals of which have distinctive characteristics found in no other surviving breed of horses, and herd laws which may date back a million years.

The questions are sure to spring to the mind: What significance is there in this uniformity of habit and appearance? Are these ponies wild? Are they indigenous? If they are indigenous, what is their relationship to the modern horse-stocks of this country, and how have they influenced them?

The Present Status of British Native Ponies

These questions are not new, and they have even caused an official enquiry to be made into the significance and status of the Hill and Moorland breeds of

ponies as recently as 1912, when a committee was appointed for this purpose by the President of the Board of Agriculture and Fisheries which reported: "And it is their emphatic and unanimous opinion that these ponies bred in the open are the natural reservoirs from which all our national breeds of light horses derive and re-invigorate many of their characteristics of temperament, courage, intelligence and resource." The findings of this enquiry all indicated the importance of these ponies in horse-breeding policy, and recommended their careful preservation, and encouragement for their breeders. Indirectly some steps have been taken to this end, although not officially, but a lack of realisation that most of the value of these breeds for foundation purposes was inherent in the fact that they were pure native stock has negatived much of the good work. At one time this reservoir of native ponies seemed inexhaustible, but not only has it recently been drained away by such channels as the slaughter of the breeding stocks, and their replacement on hill grazings by subsidised cattle and sheep, but the growing tendency to mongrelise the remaining ponies is rapidly bringing about the extinction of our native breeds, a fate which the sheep breeders take steps to avoid in their own field.

This may seem only to be of sentimental importance but it would be well to realise that in Britain alone had the whole pattern of the development of the horse's history in the West been preserved for us, partly by our geographical isolation and partly by the wise conservancy of our forefathers, and these native British animals can never be replaced.

To quote the words of His late Majesty King George VI: "The wild life of to-day is not wholly ours to dispose of as we please. It has been given to us in trust. We must account for it to those who come after us and audit our records."

Climatic and Geographic Influences in the Past

It is not within our province to discuss the geological and zoogeographical evidence presented by such authorities as Nehring, James Geikie, and Scharff, but in an attempt to explain the position and antiquity of the horse in early Britain, and to account for its arrival here, it seems necessary to draw attention, however superficially, to some of the factors to be considered before it is possible to come to any conclusion about the continuous suitability of Britain as a habitat for horses.

Horses, or rather ponies, existed in Britain long before the advent there of man, and it is not impossible that the evolution of some modern horses may have been completed in or near Britain. The great continent of Atlantis, which included North America and part of Britain, still existed during the Jurassic period when early mammals were evolved, and the Northern remnant of Atlantis formed a land bridge including Baffin's Land, Greenland, Iceland, and the Faroës, and still connected North America and Britain during the Eocene period when the earliest recognised ancestors of the horses flourished. During this period Britain was cut off by seas from the rest of Europe, but itself formed part of the large land mass which extended to the west and north and was part of the North American continent.

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When the earliest known horses occurred, that is during the Eocene period, Britain was thus directly connected with North America and had a tropical or sub-tropical climate. It was probably then separate from the rest of Europe, and Europe was cut off by seas from Asia. North America and Asia were, however, joined together. Subsequent changes tended towards a cooler climate and a land connection between Britain and France, while an extension of the North Sea covered much of Germany and the middle of Europe. At the end of this period Asia was still joined to America at the Behring Straits. Later still, when most of the Western and Northern Atlantean land extensions of Britain had disappeared, the Ice Ages began to show their influence, beneficial to horses in that the areas of grassland or tundra must have increased, but detrimental in that the advancing ice-caps would drive the horses temporarily southwards. It is noteworthy that the south and south-west of England were never covered by ice. The interglacial warm periods would provide optimum conditions for the horses, and large herds would follow the retreating ice-caps northwards again. No doubt these interglacial times marked periods of dominance of the horses.

Until relatively recently, in fact, even during the earlier periods when man's influence as a hunter became evident, the horse populations of France and Britain must have been to a great extent intermingled, as the result of the existence of the land connection. It will be necessary to make a survey of the fossil horses of Ireland to establish whether Ireland's horse population was at first similar to that of England and remained so, or whether later migrations from Scandinavia and Scotland have influenced it. Judd expressed the belief that Scandinavia and Scotland were connected together after the appearance of man in Northern Europe, while James Geikie first, and others since, have indicated that what is now the Irish Sea was formerly land in which there was a large fresh-water lake. The land connection between Britain and America by way of Scandinavia, Spitzbergen, Bear Island, and Greenland has been indicated by Engler and well supported by Scharff. The dates when these land bridges existed have not been correlated accurately with the dates of horse migrations, but it must be remembered that the horse is one of the most active and rapid colonisers known, and could take advantage of most temporary connections, unlike plants and slow-moving invertebrates.

With reference to the Pleistocene fauna of the rest of Europe, Boyd Dawkins says: "Numerous fossil bones have long been known to occur in the frozen morasses, as well as in the river deposits in the caverns, in Central and Southern Russia in Europe, as well as throughout Siberia. In the list of animals described by Dr. Brandt, discovered in the caverns of the Altai Mountains, we may remark the cave-hyena, brown bear, pouched marmot, beaver, alpine hare, elk, stag, roe, bison, *horse*, and wild boar, as well as the three extinct species, the Irish elk, the woolly rhinoceros, and the mammoth. We do not lose sight of this group of animals until we cross the Straits of Behring into the land of the Eskimos. The remains obtained by Captains Beechey and Kellett in the frozen gravels composing the cliffs of Escholtz Bay belong not merely to animals now

XUM

living in America, such as the elk, reindeer, and the bison, but also to the mammoth and the horse. The western portion of Arctic America at this time belonged to the same zoological province as Northern and Central Europe and Asia, and was not then isolated from those regions by a tract of sea."

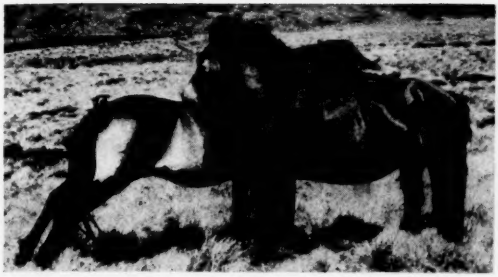
The Possibility that British Horses Survived the Ice Ages

Considerable attention has been paid to the survival and continuity of the British flora and of most of our fauna, but for such reasons as the probability of transference of horse populations by man, the horse has scarcely received as much consideration. Scharff, for instance, includes the horse in the animals of the Siberian migration, but does not list it as still inhabiting Great Britain, or having recently become extinct.

Fleure gives the prevailing view of the fate of these earliest horses: "Another group of people of different origin and habit is that evidenced by pottery found near Peterborough; they seem to have favoured low, wet areas and some have thought they came from the South Baltic region to South and Middle Scotland as well as to Eastern England. Others think the Peterborough pots largely a native adaptation of the type of pottery found at Windmill Hill. Suggestions have been made that the Peterborough people brought the horse with them because horse remains have been found with their pottery, This needs further investigation, but, in any case, the horse did not become important in Britain until much later. Horse remains occur in megaliths in Brittany and the Iberian Peninsula, but we are not sure whether they were domesticated animals. It is probable that the wild horse did not reach Britain after the Ice Age. The cave-bear, cave-hyena, mammoth, and other beasts of the Ice Ages had died out. The deer, the wolf, wild cattle, swine and possibly sheep were features of our fauna along with beavers and lemmings."

It must be assumed from these statements that the last cold phase is considered to have brought about the extermination of our wild horses, but note should be taken that the Peterborough folk "favoured low wet areas," which horses do not. However, if we may quote Gordon Childe: "The Aurignacians may have retreated at the onset of another period of intensified cold, so severe and prolonged over so many centuries or millenia as to cause a considerable extension of the glaciers and ice-sheets. Thus the entrance to Cae Gwynn, a cave in the Vale of Clwyd, was sealed up by the moraine of a glacier after it had served as a temporary habitat for man. Eventually other transient visitors arrived. Gravettians whose kinsmen and ancestors had specialised in hunting big game on open steppes and tundras in South Russia, Central Europe, France and Spain. They arrived in a late stage of their cultural evolution, termed in France the Font Robert stage, and may already have been accompanied by stragglers of a different people—the Solutreans, who in parts of France and Northern Spain succeed the Gravettians in the archæological record, for at many sites flint instruments pressure-flaked in the so-called Proto-Solutrean style occur as well as Gravettian tools.

"On their arrival they still found a few mammoth, woolly rhinoceros, bison, and reindeer as well as plenty of horses and wild oxen in Britain. But the



M.G.E.

FIG. 1.
Exmoor ponies—a race of small horses.

M.G.E.

FIG. 2.
Part of the Pentland Hills herd in November.

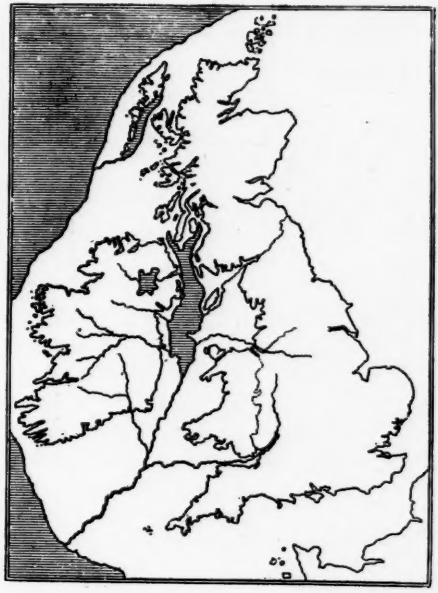


FIG. 3.
Map of the British Islands and surrounding area at a time when the earlier members of the southern migration reached England. (Only some of the rivers have been indicated. The shaded parts represent water, the light land.) R. F. Scharff.

M.G.E.

FIG. 4.
"They do not expect and certainly do not receive any shelter or food from man."

(Article by Speed and Etherington, page 329)

M.G.E.

Fig. 5.
"It is a severe winter indeed that takes any toll of such ponies."

Fig. 6.
A Palæolithic artist's impression. (Cave painting from the Cave of Niaux Ariège.)
[*By kind permission of the American Museum.*

M.G.E.

Fig. 7.
A photographic impression (the Pentland Hills).

R. S. Hood.

Fig. 8.
The humerus of an Exmoor pony (right) compared with a Pleistocene Alaskan specimen.

M.G.E.

Fig. 9.
This typical foal was born in November and remained with the herd on the Pentland Hills.

(*Article by Speed and Etherington, page 329*)

climate soon—i.e., in the next two or three thousand years—began to grow milder. First the rhinoceros and then the mammoth died out, and at last the reindeer vanished even from Derbyshire." He goes on to say: "One's general impression is that during the closing phases of the last Ice Age Southern Britain was occupied by a very sparse and far from prosperous population of hunters and collectors, living for the most part in caves, but also camping on the open plains in East Anglia and Lincolnshire. None of the caves, save Paviland, seems to have been occupied at all intensively nor for long continuous periods. The population must have been very small; Clark's estimate for the winter months of a total of 250 is not extravagantly low."

His reasoned and well-supported description of the period immediately following the last phase of the Ice Ages thus gives a picture of a climate becoming more and more congenial in a land well stocked with wild horses and sparsely populated by human hunters. One may here remark an observation made in the Scottish Highlands recently by a deer-stalker to the effect that if the winter should be so severe that the ponies die, then the sheep and the deer will have died first. This seems to be the order of vulnerability to climatic hardships: first to die are the sheep, then the deer, and the ponies are the last. It is a severe winter indeed that takes any toll of such ponies as the native garrons of Scotland or the ponies of Exmoor provided they have something of a range of rough ground and have no alien blood to weaken them, and they do not expect, and certainly do not receive, any shelter or food from man.

The Domestication of the Horse

The horse has held a peculiar position because of its adaptability and tractability, and although man hunted it for food, he very quickly found additional uses for it, and so, while wild herds may still have roamed the country, some horses became domesticated. This domestication, although it provided protection, brought other consequences, the chief being that emphasis was always laid upon attempts made to introduce variations by cross-breeding.

In the case of the horse, we feel justified in requiring a definition of the word "domestication." Clearly the root derivation, "living in houses," or "housed," must be amplified, but if we widen the meaning to include animals dependent upon man for their survival then we do not include the native ponies which do very well when not interfered with. If, on the other hand, we stretch the meaning still further and include all the animals controlled by man, then such animals as the reindeer of Lapland and to some extent our British red deer must be considered as domestic animals, since in the latter case, for instance, the deer are contained within fences, their numbers controlled, and their breeding influenced by man's selection in such forms as transferring stags from one forest to another or by careful selection by shooting unwanted animals and sparing the heaviest or best antlered.

We believe that some latitude is required in this definition of the domestication of the horse. Some horses are clearly the products of a cross-breeding and selection by man, are housed by him for all or part of the year, depend on him for at least a portion of their food, and are probably derived by him from the

XUM

native horses of some other country. They show many divergencies from the structural form of the prototype horses. Such horses are truly domesticated.

Other horses, but this refers only to the " ponies," may show little or no sign of cross-breeding and selection by man, are never housed, fend for themselves and find all their own food, and show such close similarity to the indigenous horses of the country, as well as living in the very area where their prototypes lived, that it would be much easier to recognise them as survivals of these native wild animals than to postulate their extermination and re-introduction in their original form and habitat.

It is, however, customary to describe our ponies as " feral." *Feræ naturæ*, or wild animals, may thus be given this qualified title of " feral " to indicate that there is a suspicion that at some period, however remote, they may have been domesticated, but having escaped from domestication, they have reverted to a wild life, and perhaps re-acquired the wild appearance.

For the purposes of our study of the Exmoor pony we have accepted that there are these three possibilities: that the Exmoor pony may be a " domestic " animal; that it may have been a domestic animal and reverted to a wild life; or lastly, that it may be truly wild and native.

The Ancestors of Our Native British Ponies

It would be unscientific and unwise to follow the usual course of accepting our modern, specialised breeds of horses and ponies as an end in themselves, and an unqualified improvement on all that had gone before. These modern artificial breeds are the products of cross-breeding, and if we accept that the horse had a multiple origin, then we must realise that the genetical constitution of the cross-breds will be a mixture in which incompatibles may be present. This being so, it becomes necessary to know the sources from which the ancestors of our modern breeds are derived. Cossar Ewart's investigations into the " Multiple Origins of Horses and Ponies " brought him to a similar conclusion, and although his broad classification into Forest, Steppe, and Plateau types is scarcely adequate for the purpose, it was at least a sound beginning.

In Britain there is a surprisingly large amount of fossil horse material awaiting the investigator. Much of it has lain unexamined in our museums for many, in some cases a hundred, years, and much of it has been identified at the excavation sites as " Equus " and turned in again with the spoil. It is not popularly understood that the oldest horse fossils known to science were found in Britain in the London clays. These fossils consisted of the skulls of Hyracotherium, a primitive form of Eohippus, a small creature about the size of a cat and with four toes on the fore feet and three on the hind feet. Since it occurred in the Lower Eocene, we may claim that we had in Britain the oldest known horse and that it lived here perhaps seventy million years ago. It is therefore also not unreasonable to claim that Britain could have been the cradle of the horse. Certainly there are wide gaps in the evidence of horse evolution in Britain caused no doubt by the destruction of the later geological strata by the process of attrition caused by weathering and ice movements. It is only the fortuitous chance of the formation of the Red Crags of Norfolk and Suffolk

that has preserved for us fossils of the Miocene or Pliocene three-toed horses, Hipparion, which lived here within the last fifteen million years.

When we come to the Pleistocene, or recent, horses we find a super-abundance of material in Britain for study. Mr. Balch, of the Wells Museum, kindly lent us some of these bones with an account of them and of the strata in which they were found. For instance, in Aveline's Hole, Burrington, the horse occurs with the bones and artefacts of Palæolithic man, while later man is absent. Sir Arthur Keith dated this occupation at 8,000 to 10,000 B.C. Found here with the horse bones were those of thirty Great Deer (*Strongylocerus spelæa Owen*), all of which had been killed. In the absence of evidence that cave-lions and cave-hyenas used this cave, it can only be assumed that the horses had been brought to it by man. A number of horse teeth were present, which had been drilled or notched for suspension or as toggles.

As additional proof of the antiquity of the horse in our native fauna it may be noted that at Gray's Thurrock in Essex the old Pleistocene alluvia of the Thames has yielded up the bones of the horse along with those of the elephant rhinoceros, hippopotamus, and bear, as noted by James Geikie.

The Two Original Types of Native Ponies

In all, the horse is represented, sometimes abundantly, in 21 of the 27 known excavation sites of Mendip, the smaller, or Exmoor, type being present from the early to the latest strata, whilst a larger, or pack-horse, type occurs only in the later strata. The next most frequently occurring animals in these sites are the red fox, in 18, and man or his works in 16. Since the horse does not enter such small caves willingly, it seems evident that he must have been numerous over a long period of time on the limestone plateau of the Mendips. The red deer, which also still lives wild on Exmoor, is found in 15 sites.

These prototype indigenous horses were obviously well established in the interglacial warm periods in Britain and there is no evidence from the fossils of that age that they interbred with each other. From such evidence as we can get, for instance the cave paintings at Lascaux, we believe that these indigenous horses were of the dark brown or mouse dun colour typical of the horses native to an Atlantic climate. How they got to Britain, assuming that they did not complete their evolution here, is a matter for conjecture, but the small pony, the Exmoor pony prototype, probably followed the Oriental migration route, entering Europe through Asia Minor and travelling through the Mediterranean region when large land areas and land bridges still existed there, and across the area which is now the English Channel. Such a migration route is well described by Scharff, who believed that "members of the Oriental migration reached Europe across an old land connection which united Turkey, Greece and Syria, while the Siberian animals invaded our continent to the north of the Caspian and Caucasus." The pack horse prototype may have been included in the Siberian migration. He pointed out that members of the Oriental migration form a very large percentage of the European fauna. This view is supported by the evidence of the living animals and by the distribution of fossil remains.

XUM

The Exmoor Pony Prototype

Certainly this Exmoor pony type was the first modern horse, or rather pony, to become established in Britain, and its teeth and bones have been recovered from so many districts in Britain and over so long a series of geological and archæological phases that we feel that it may truly claim to being our representative native horse. That it may have evolved in Britain or near it is not entirely an impossibility.

We have seen bones which compared closely, some exactly, with it, from places as widely separated geographically as the Dordogne in France, Essex, Sussex, Yorkshire, Somerset—where it is especially numerous—from Kintyre, Barra, and elsewhere in Scotland, and from Alaska. The specimens from the Dordogne collection included both the smaller and the larger ponies, the former represented in most of the strata in the caves, while the larger pony occurs in the later layers only, as is the case in the Mendips. From Sussex, the specimens in the famous Mantell collection of the British Museum are mostly from chalk conglomerate. The Alaskan material, now in the possession of the Royal Scottish Museum, is extremely interesting and includes the half of a mandible, parts of the upper portion of a skull, and limb bones, and is from Pleistocene deposits of river gravels mainly.

In addition to these specimens to which we have had access, Nehring refers to small, lightly-built fossil horses, which he describes as the "Schussenried" horses, from the place where they were discovered at an open-air habitation superimposed upon the terminal moraine of the Rhine glacier, and representing, to quote Munro, the reindeer period in its purer form. His measurements of these Schussenried horses compare surprisingly well with his measurements of an Exmoor pony. He recognises them as similar to the pony-races of some of the islands separated from the continent of Europe, and while he considers these races to have developed separately in their own environment, we believe them to be isolated remnants of a great migration. This migration of the small pony should well repay investigation, and it is possible, though at present it is only our hypothesis, that the fossil horse of the Lofoten Islands and the modern ponies of equatorial Africa, as well as the ponies of the Shan Hills of Burma and numerous others, will prove to be fundamentally of the same race. The account given by Mungo Park of an encounter with wild horses on his first journey to the Upper Niger strikes a familiar note to anyone acquainted with the wild herds of Exmoor ponies:—

"About four miles north of Simbing we came to a small stream of water, where we observed a number of wild horses; they were all of one colour, and galloped away from us at an easy rate, frequently stopping and looking back. The negroes hunt them for food, and their flesh is much esteemed."

Such a sight must have been a common one for Palæolithic man. To us it conveys at once the impression given by a herd of wild ponies: the uniformity of their colouring, their easy and unhurried action however fast they may be moving, and their inquisitiveness and intelligence which make them stop frequently to watch the behaviour of a possible enemy, are all familiar features

of our Exmoor pony herds. In an account of the Foulahs, Park describes the agriculture of their country, which lay on the West Coast of Africa about latitude 15°, between the Gambia river and the Senegal river, and notes that they possessed some excellent horses, the breed of which seemed to be a mixture of the Arabian with the *original African*. This account was written in December, 1795. Throughout all the lands in which the influence of Arabic and Semitic trading has been felt, the "Arab" horse has proved a remunerative article of commerce.

The Larger, or Pack-horse, Type of Pony

As for the larger pony, this probably came to our country later, but still before the end of the last ice-age, and, although not so widely distributed, was numerous enough in its chosen low-ground habitat. In contrast to the Oriental route of the smaller pony, it probably followed one of the Siberian migration routes through the Great Lowland Plain of Europe, which lies to the north of the Caspian, from Asia; and about the Plains of Paris, and elsewhere in France, established itself so strongly—according to the evidence of the bones of more than 40,000 of them found at Solutre, for instance—that its numbers were great enough to ensure an overflow into Britain over the disappearing land bridges of what is now the North Sea.

This station of Solutre in France, in the Province Saône-et-Loire, is particularly interesting as a large open-air encampment of Palæolithic men. Munro writes of it as follows:—

"Human occupancy was indicated by a number of hearths, around which characteristic implements of flint and reindeer horn were found. The surrounding debris consisted almost entirely of broken bones, chiefly those of horse and reindeer, evidently the remains of animals that had been used as food by the occupants. Encircling the south side, the bones of horses were amassed to such an extent as to form a kind of protective wall to the settlement . . . Professor Joussaint, of the Veterinary School at Lyons, bringing the total up to 40,000 at least. Of the fauna identified at Solutre, besides the horse and reindeer, the following may be mentioned as evidence of the Palæolithic character of the station: *Elephas primogenius* (portions of tusks, teeth, and bones in considerable quantity scattered throughout the debris); *Cervus canadensis* (formerly taken for Megaceros) was identified by M. Dupont, who had frequently found remains of this animal in the Belgian coves; *Ursus arctos* (a tooth and some rib-fragments); *Ursus spelæus, Canis lupus, Canis vulpes, Hyæna spelæa,* etc. The mammoth continued, but the woolly rhinoceros disappeared from the chronological horizon of the station. On the other hand, the reindeer and the horse, which was feebly represented in the Mousterian epoch, were met with here in great abundance."

We ourselves have examined fossils from the British Museum of Natural History of the small pony dated at about 100,000 B.C., and, from other sources, fossils of the larger one assumed to be about 60,000 B.C., while earliest modern Man is dated by some authorities at approximately 40,000 B.C. in Europe.

These two prototype ponies were present in great numbers in Britain

before the last phases of the Ice-age, and in general the smaller pony is represented in the older geological layers as well as in those more recent ones containing the larger pony. These ponies were not introduced by man, and the smaller one at least was in the country long before him.

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(To be concluded)

OBSERVATIONS ON THE MORTALITY IN THREE FLOCKS OF POULTRY, WITH SPECIAL REFERENCE TO THE INCIDENCE OF LEUKOSIS

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THERE have been few published records of flock mortality in this country in recent years. Campbell (1945) analysed a series of 2,063 autopsies on fowls during the years 1940-44. Dudley *et al.* (1941) published an analysis of mortality at laying trials in this country from 1929-37. For earlier data see Matheson (1927), Kerr (1928), Matheson and Wilson (1933), Dalling *et al.* (1937), and Montgomery (1938). In America, recent papers on this subject have been published by Hutt (1938), Goss (1940), and Bullis and Olson (1943).

It is our aim to present, from time to time, detailed studies of mortality in certain flocks, the records of which are available.

The present paper deals with the mortality in three flocks in which no epidemic of an infectious nature, other than coccidiosis, has occurred during the period reviewed. The results may be taken, therefore, as indicative of the incidence of mortality occurring in the flocks in this country at the present time. The birds in these three flocks were under progeny test, culling was carried out only *in extremis*, all culls and deaths being submitted for autopsy at this laboratory. Throughout this paper the percentages will be given, firstly as the percentage of the number of birds in the flock or group, and in parentheses

immediately following this figure will be the corresponding percentage of the total deaths.

Flock 1 (Animal Health Trust)

This was started in 1948 by the purchase of Canadian Barred Rocks and Brown Leghorns as day-old chicks. In the present report, which covers the years 1948-51, the figures for losses up to 5 months of age refer to the mixed population of pullets and cockerels, kept in fold units. After 5 months of age, the mortality figures refer to pullets only, maintained in both fold and built-up litter units.

Flock 2 (the first test at the Poultry Production and Progeny Trials)

Each pen of 12 females at the Trials was mated at the beginning of 1950 to a cockerel sent by each respective breeder. Twenty of the resulting pullet progeny on reaching maturity were placed in built-up litter units and retained under test for a further 48 weeks. The parent birds were maintained in movable pens.

Flock 3

This consisted of a closed flock of White Leghorns undergoing progeny test at Shilton in Oxfordshire. A total of 743 progeny hatched in 1950 and maintained in fold units on grass form the material in this report.

I. The Level of Total Mortality in the Three Flocks

Flock 1

In Table I is shown the total mortality occurring during the period 1948-50. It will be seen that the mortality rose considerably during 1950 both in the Barred Rocks (32.3 per cent) and Brown Leghorns (20.4 per cent). This rise was due almost entirely to a disease of uncertain ætiology (Gordon, 1951), which caused losses in those birds under 5 months of age. If losses due to this disease are omitted, mortality is reduced to 23 per cent in the Barred Rocks and 14 per cent in the Brown Leghorns — not significantly different from that observed in the previous two years, viz., 1948 and 1949.

It will be observed: (1) that the mortality during the brooding period remained at a low level, and did not differ greatly from 2 per cent for both breeds during each of the three years; (2) that the mortality before the birds reached maturity contributed in no small measure to mortality for the whole of the first twelve months; and (3) that the higher level of mortality found in the Barred Rocks, compared with the Brown Leghorns, was largely due to a higher level of mortality after 5 months.

Flock 2

During the first year (1949-50) of the Trials, the mortality figures were available for a period of 48 weeks, commencing from the date of entry. In this paper, only the mortality during the first 7 months of the production period for the progeny and parents is discussed. This corresponds to the 5-12 month period in Flock 1. The total mortality in the 3,430 pullet progeny was 2.4 per cent during the first six weeks after hatching, i.e., of the same order as Flock 1. The average mortality up to the time of selection, when the age

TABLE I

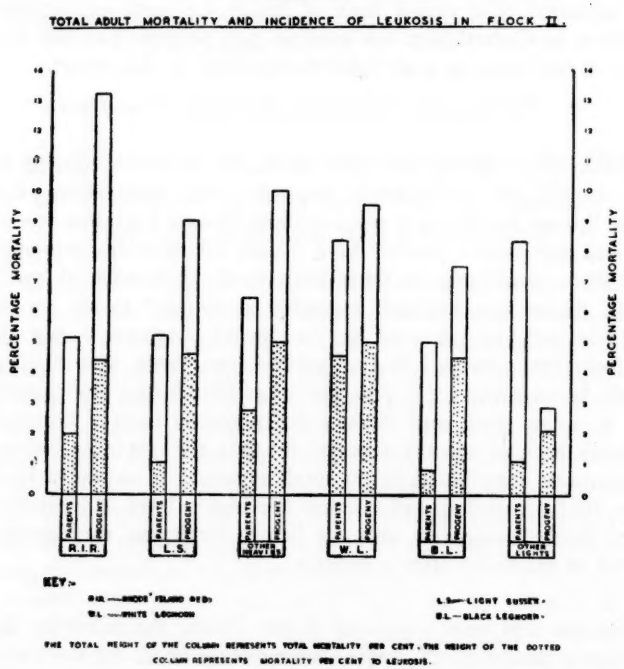
Total mortality and mortality due to leukosis in Flock 1 (1948-50)

Breed	Year	Total No. of chicks retained	Total mortality % 0-6 weeks	0-5 weeks	0-12 months	Leukosis % 0-5 months % incidence in flock	0-5 months % of the mortality	0-12 months % incidence in flock	0-12 months % of the mortality
Barred Rocks	1948	531	2.4	6.4	19.0	2.5	39.1	7.3	38.4
	1949	1,438	1.5	10.7	19.7	0.8	7.5	3.1	15.7
	1950	767	2.5	13.0	32.3	0.6	4.6	4.5	13.9
				(6.9)	(22.8)				
Brown Leghorns	1948	253	4.7	8.7	15.8	1.3	14.9	1.5	9.5
	1949	748	1.5	6.0	13.6	0.8	12.1	5.5	40.5
	1950	438	1.4	12.3	20.4	0.3	2.4	1.5	7.5
				(3.9)	(13.5)				

Figures in parentheses are mortality figures excluding the disease of unknown ætiology

of the heavy breeds was 25 weeks and the light breeds 22 weeks, was 4.6 per cent; this was considerably less than in Flock 1 (see Table I).

FIG. 1.



The losses in the parents and progeny over a 7-month period after reaching maturity are illustrated in Fig. I. The four main breeds under test were R.I.R.s, Light Sussex, White Leghorns and Black Leghorns. The remainder are classified for the purpose of this analysis into "other heavy breeds" and "other light breeds."

In all breeds except the progeny of the other light breeds, the mortality was higher in the progeny than in the parents. This mortality was most marked in the R.I.R.s and was due mainly to intestinal coccidiosis.

Flock 3

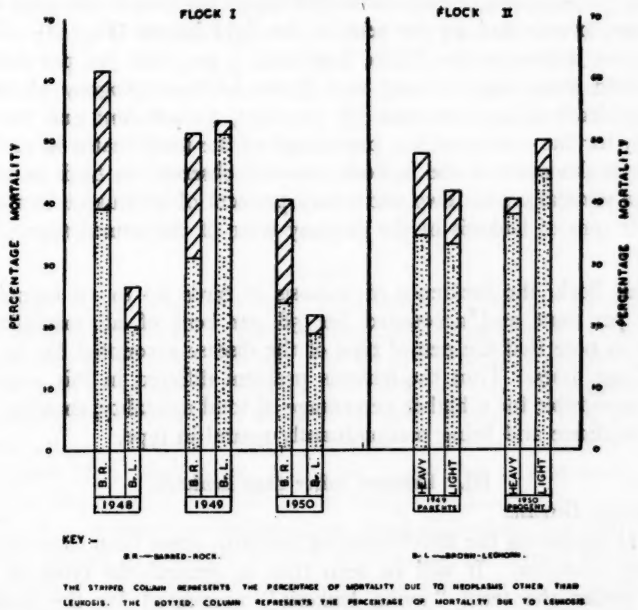
The figures available are for 0-12 months pullet mortality. From a total of 743 birds hatched in 1950, 201 or 27 per cent died. Considerable variation in the mortality of the progeny of different cockerels under test was observed.

II. The Incidence of Leukosis in the Three Flocks

In the post-mortem examination of specimens, the American classification of leukosis (Jungherr *et al.*, 1941) was used. Doubts as to whether or not

FIG. II.

PERCENTAGE OF TOTAL ADULT MORTALITY DUE TO LEUKOSIS AND TO OTHER FORMS OF NEOPLASIA IN FLOCKS I AND II.



osteopetrosis and types other than the neural or visceral forms should or should not be included in the complex do not, in fact, have any significant effect on this analysis as they were so infrequent.

Flock 1

The incidence of leukosis during 1948-50 is shown in Table I. It will be seen that the mortality due to leukosis was highest in the Barred Rocks, being 7 per cent (38 per cent) of the birds in the flock in 1948, and highest in the Brown Leghorns, 5 per cent (40 per cent), in 1949. In the years in which

XUM

the highest incidence of leukosis occurred (see Table I), the percentage of deaths due to leukosis was also highest (see Fig. I). This occurred in 1948 in the Barred Rocks and in 1949 in the Brown Leghorns.

Most of the cases of leukosis were of the visceral type. In 1948 a number of cases of neural lymphomatosis occurred, but in the following year only two cases were recognised. Cases of myelocytoma have occurred, particularly during 1950, when six were recognised. Erythroblastosis and myeloid leukosis were seen less frequently.

Flock 2 (Fig. 2)

In the parent birds, leukosis accounted for 35 per cent of the total losses in the heavy breeds and 33 per cent in the light breeds. The total incidence of leukosis was highest in the White Leghorns, viz., 4.5 per cent (54 per cent); between 1 per cent (20 per cent) and 2 per cent (38 per cent) in the Light Sussex and Rhode Island Reds; and below 1 per cent (17 per cent) in the Black Leghorns.

In the progeny, this disease accounted for 38 per cent of the total mortality in the heavy breeds and 45 per cent in the light breeds (Fig. II). The total incidence was highest in the White Leghorns, 5 per cent (52 per cent). The Rhode Island Red, Light Sussex and Black Leghorn progeny all showed a leukosis incidence of 4.5 per cent (33 per cent, 51 per cent and 60 per cent respectively for the corresponding percentage of the total deaths in each breed).

Most of the cases of the leukosis complex observed in birds at the Trials were of the visceral type. Two and a half per cent of all leukosis in the parents and 12 per cent of leukosis in the progeny were of the neural type.

Flock 3

In this flock, the incidence of leukosis in birds up to 12 months of age was 15.8 per cent and accounted for 58 per cent of all mortality. It is important to note that the neural type of the disease accounted for 72 per cent of all leukosis cases. Thus the leukosis problem differed in this establishment in being responsible for a higher percentage of total mortality, showing a higher absolute incidence and being predominantly neural in type.

III. Diseases other than Leukosis

(a) Neoplastic Diseases

Fig. II represents the distribution of tumours, other than those included in the leukosis complex. It will be seen that in general the types of tumours classified under the term "avian leukosis" accounted for the bulk of the mortality due to neoplasia.

(b) Diseases of the Reproductive System, other than Neoplasia

This group of diseases in 1948 made an important contribution to mortality from 5-12 months of age in Flock 1 (Barred Rocks and Brown Leghorns), causing 12 per cent of all mortality in the former and 27 per cent in the latter. A marked decline in losses due to these diseases was seen the following year, accounting for 1 per cent of the deaths in the Barred Rocks and 7 per cent in the Brown Leghorns. In 1950 this trend continued—only 1 per cent of the

XUM

Barred Rock deaths were attributed to disease in this category, no deaths from this cause occurring in the Brown Leghorns.

In Flock 3, mortality from reproductive disease occurred to a negligible extent—only three cases being recorded.

(*c*) *Miscellaneous Deaths*

Under this heading fall those diseases not covered by the foregoing classification. It includes circulatory disorders, nephritis, and specific diseases such as coccidiosis. Deaths for which the true cause was not determined with certainty are also included under this category.

In Flock 1, losses falling into the miscellaneous group were highest in 1950 and accounted for 63 per cent of the total mortality in adult birds. No major epidemics of an infectious nature occurred in the birds over 5 months of age. Coccidiosis accounted for deaths in a few chicks in 1948 but has never been a serious problem.

In Flock 2, deaths due to miscellaneous disorders accounted for an appreciable percentage of the losses, especially in the progeny, where 54 per cent of the total mortality in the heavy breeds and 40 per cent of total mortality in the light breeds fell into this group of diseases. In the parent stock 41 per cent of total mortality in the heavy breeds, and 29 per cent of total mortality in the light breeds, was caused by this group. Coccidiosis accounted for 43 per cent of the miscellaneous deaths occurring in the progeny.

In Flock 3, losses due to miscellaneous causes were rather masked by the high incidence of leukosis. However, listerellosis, adult coccidiosis, and a high level of intestinal parasitism were noted.

Discussion

Although many conditions may be erroneously classified as neoplasia on autopsy unsupplemented by routine histological examination, it is also probable that many cases of neoplastic diseases may be overlooked. Accurate estimations of the true level of neoplastic disease in a flock can only be obtained when a careful histological examination is made on every autopsy (Goss, 1940; Bullis and Olson, 1943; Campbell, 1945). However, the results of Olson and Bullis (1942) suggest that macroscopic diagnosis may give a reasonably accurate indication of the level of leukosis in any sample of birds.

In Flock 1, a yearly variation in the level of leukosis has been observed. This disease existed in a higher level (7 per cent) in the Barred Rocks in 1948, whilst the Brown Leghorns were more severely affected (5 per cent) in 1949, although both groups of birds had been exposed to a similar environment, i.e., built-up litter and fold units. Neoplastic diseases, including leukosis, accounted for 51 per cent of all Barred Rock mortality over 5 months in the years 1948-50. The corresponding figure for the Brown Leghorns was 38 per cent. The incidence of neoplasia in the Barred Rocks corresponds closely to 48 per cent recorded by Hutt (1938) but differs from the figure of 19.5 per cent given by Goss (1940). Dudley *et al.* (1941), in an analysis of mortality at egg-laying trials in Great Britain during the period 1929-37, observed an increase in deaths due to this cause from 16.6 per cent to 32.9 per cent in 1936-37.

XUM

Campbell (1945) found 18 per cent of autopsies to be affected with neoplastic disease.

In Flock 2, during the first seven months both of the progeny test and parent test, the total mortality caused by leukosis was highest in the White Leghorns, being 5 per cent (53 per cent) for both parents and progeny. In the Black Leghorn parents, leukosis mortality was the lowest in the series, being 0.83 per cent (17 per cent). In the Black Leghorn progeny, however, this figure reached 4.5 per cent (60 per cent). The R.I.R. parents showed a total mortality caused by leukosis of 2 per cent (38 per cent), whilst in the R.I.R. progeny the incidence was also in the order of 4.5 per cent (33 per cent). Thus, whilst the incidence of leukosis varied considerably amongst the parent stock, the incidence in the progeny, with the exception of the "other light breeds" comprising a relatively smaller number of birds, was remarkably constant at about 4.5 per cent. It will also be noted that, although the leukosis incidence was constant, the total mortality in the different groups of progeny reared in he similar environment varied considerably. Conversely, it was shown in Flock 1 that whilst mortality, excluding the disease of unknown ætiology previously mentioned, remained constant for the two breeds over the three years, the leukosis incidence varied considerably. Our failure to observe a relationship between the level of leukosis and mortality other than leukosis is in agreement with Waters (1951). Lush (1948), on the other hand, found a positive correlation between leukosis and mortality other than leukosis.

Most of the deaths from lymphomatosis and allied disorders occur shortly before and shortly after 5 months of age. This is illustrated by the fact that in the first 7 months of the parent pen production test in Flock 2, losses caused by neoplastic diseases, including leukosis, accounted for 45.5 per cent of total mortality; this figure fell to 35.5 per cent by the end of the 48-week trial period. Surveys of mortality can be critically compared only if the age of the birds is taken into consideration.

In the 1949 parent birds, total mortality due to all causes increased from 5.1 per cent during the first 7 months to 11.3 per cent over the whole period. This increase in mortality during the closing months was largely due to reproductive disorders, which rose in relative importance from 17.4 per cent at the end of the first 7 months to 28 per cent at the end of 48 weeks. Dudley *et al.* (1941) also noted that more deaths occurred from reproductive disorders in the second half of the year than in the first half, and accepted this as evidence to support the general contention that the disease known as egg peritonitis, which accounts for most of the losses in this group, is due to weakening of the reproductive organs, consequent on heavy egg production over a long period.

The present authors are uncertain what interpretation to draw from their observations of the marked decline in losses, reproductive in origin, that they have observed in Flock 1. There has been no parallel decrease in egg production. If the latter had occurred it would have lent some support to the suggestion of Dudley *et al.* (1941).

In Flock 3 in 1950, mortality up to 12 months of age caused by leukosis

reached the high figure of 15.8 per cent, compared with approximately 5 per cent in Flocks 1 and 2. In 1948, when Flock 3 was established, leukosis was not diagnosed.

It has frequently been observed (Gildow *et al.*, 1940) that in a flock in which leukosis exists at a low level in the first year of the flock's establishment, the disease may reach a high level during the third year. This has been our experience in Flock 3. It is difficult, in view of the conflicting evidence in the natural transmission of leukosis (Cole, 1949; Waters, 1945), to explain why the third year should appear to be a critical period.

Our observation of a higher percentage of neuro-lymphomatosis and coccidiosis in the progeny in Flock 2 than in their parents is interesting in view of the findings noted by earlier workers (Wilson, 1944) of an association between neuro-lymphomatosis and intestinal coccidiosis.

This and previous reports have shown the importance of neoplastic diseases of the fowl. It is of interest to note that, in the fowl, a very high level of mortality caused by leukosis occurs in the first to twelfth month of life; that is, at a relatively younger age compared with the age incidence of the majority of the leukæmias of man (Willis, 1948; Greenwood *et al.*, 1951).

Summary

(1) The levels of mortality in three flocks of poultry during the years 1948-50 have been recorded.

(2) Losses due to neoplastic diseases in general accounted for a very high percentage of deaths during the five to twelve months of age period. The avian leukosis complex accounted for the major proportion of these losses.

(3) Variations in types and incidence of the leukosis complex have been observed. In Flock 1 the incidence of the disease varied from year to year and between the two breeds although both breeds were maintained under the same conditions of management. In Flock 2 the incidence of leukosis was highest in the White Leghorns, both in the 1949 parent stock and in their progeny. In Flock 3 the greater proportion of the leukosis mortality was due to neural lymphomatosis, this type being uncommon in the other two flocks.

Acknowledgments

We wish to thank the Management and Directors of the Poultry Production and Progeny Trials for permission to publish data regarding Flock 2, and Dr. R. Coles and Mr. Cumber for their co-operation in the survey of disease in Flock 3.

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XUM

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THE CLINICAL ANATOMY OF THE STIFLE OF THE DOG

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INJURIES to the stifle joint are of common occurrence, and the clinician who may be called upon to alleviate or resolve the effects of trauma or disease must be in possession of a considerable fund of anatomical knowledge before he can apply remedial treatment in a rational manner. An examination of the literature reveals certain deficiencies in the accounts of this joint, particularly in relation to the mechanism and function. The object of this paper is to make good some of these deficiencies and to give an account of the radiological anatomy that has been previously undescribed.

Surface Anatomy

The general conformation of the stifle region is determined by the bones forming the articulation, the angle at which they meet, and by the muscles that clothe the joint, particularly over its posterior aspect. In greyhounds and other fine-limbed breeds much of the anatomy of the region may be determined by simple inspection and palpation, and where palpation is combined with manipulation most of the more important structures may be identified in one or other position of the joint. The details that may be recognised in individual animals will obviously vary with breed and condition.

Anterior aspect.—The anterior contour of the stifle region is formed successively by the quadriceps femoris muscle, the patella, the straight patellar ligament, and the tibial crest, which stands out as a prominent subcutaneous ridge. The patella may be palpated over its entire anterior surface, and to each side of the patella are situated the lips of the trochlea: these may be followed downwards and backwards towards the articular condyles. Distal to the patella the boundaries of the straight patellar ligament may be palpated, and to each side of this the infra-patellar pad of fat may be appreciated.

Medial aspect.—The bony landmarks that may be recognised are the continuation of the medial ridge of the trochlea, part of the medial condyle of the femur, and the greater part of the periphery of the medial condyle of the tibia. Distal to this the medial aspect of the shaft of the tibia is subcutaneous.

The femoral and tibial condyles together form a prominent projection on this aspect of the joint. In the upper part of this region the posterior border of the sartorius muscle and both borders of the gracilis muscle may be readily identified: distal to the gracilis the cord-like tendon of the semitendinosus may be palpated and is recognised most easily when the joint is extended. On semi-flexion the more posterior part of the semimembranosus may be felt lying deep to the gracilis and proceeding to its insertion on the tibia. The medial collateral ligament of the joint may be palpated. In the distal part of this region the medial head of the gastrocnemius muscle is prominent and on deep palpation it may be possible to feel the fabella in its origin.

Lateral aspect.—The corresponding parts of the femur and the tibial condyle may be identified together with the head of the fibula. Of the other structures, the vastus lateralis muscle and the lateral head of the gastrocnemius muscle and the lateral collateral ligament may be identified with certainty.

Posterior aspect.—In addition to the foregoing structures, palpation of the posterior aspect permits identification of the popliteal lymph node lying in a superficial position between the heads of the gastrocnemius muscle.

Mechanics of the Stifle Joint

The stifle joint is a complex articulation situated at the ends of two long bones that meet at an angle and serve as levers to magnify disruptive forces; despite this apparent vulnerability the stifle is, however, relatively immune from injury and is one of the more secure articulations of the hind limb. The angulation which at first sight appears a disadvantage is in fact a source of additional strength. In analysing the movements the joint may be resolved into two components—the extensor mechanism and the true hinge joint.

The extensor apparatus comprises the quadriceps femoris muscle, the patella into which the muscle is inserted, the straight patellar ligament that is the functional continuation of the muscle, and the tibial tuberosity; associated with this apparatus is the trochlea of the femur. Two common clinical conditions are associated with this mechanism—luxation of the patella and avulsion of the tibial tuberosity. The low lips of the trochlea and the poor development of the femoro-patellar ligaments explain the frequency of the first condition. Inward and outward dislocation both occur, but that to the inside is the more common. The detachment of the tibial tuberosity due to the pull of the quadriceps muscle is met with in young animals and may be associated with preceding faulty bone development.

The true joint is distinguished from other hinge joints by the presence of two fibro-cartilaginous pads or menisci inserted between the opposing articular surfaces, and it is the presence of these menisci with their anchoring ligaments which is responsible for much of the complexity of this articulation.

In addition to these menisci the joint is remarkable for the presence of two internal ligaments, the cruciate ligaments, connecting the femur with the tibia. As with other joints, the stifle is supported by medial and lateral collateral ligaments passing from the extremity of one bone to the other—in this case from the femur to the tibia and fibula, where they have a strong insertion at

XUM

some distance from the articular margin. These ligaments serve to limit rotation and over-extension and maintain the various articular surfaces in close apposition throughout the range of normal movement. The cruciate ligaments have a more specialised function: the anterior cruciate ligament arises by a broad origin from the head of the tibia anterior to the tibial spine and between the anterior horns of the menisci, and is inserted on to the medial surface of the lateral femoral condyle. The posterior cruciate is longer and runs from the medial surface of the popliteal notch of the tibia to be inserted into the lateral surface of the medial femoral condyle. In their passage from origin to insertion the ligaments wind around one another in a spiral fashion: in some specimens each ligament may be divided into two parts.

The menisci are two fibro-cartilaginous crescents that lie between the femur and the tibia and which are adapted to the convexities of the former and to the undulations of the latter. Each is wedge-shaped on cross-section and is attached by the thick convex peripheral border to the joint capsule, while the thin concave inner border is directed towards the inter-condyloid eminence of the tibia. The menisci do not occupy the whole of the articular surface; in the standing position, when the bones meet at an angle of 135° or thereabouts, the posterior borders of the menisci are close to the posterior edge of the articular surface of the tibia with the lateral meniscus slightly advanced, leaving a greater area of tibial articular surface uncovered in front of them. The lateral meniscus is longer and narrower than the medial one, and its capsular attachment is interrupted postero-laterally where the intracapsular tendon of the popliteus muscle passes from its origin on the femur.

Four ligaments attach the anterior and the posterior cornua of the menisci to the tibia and are named in accordance with their position (see Fig. 1). The additional posterior femoral meniscal and also the inter-meniscal ligament should be noted. It will be appreciated that the effect of these ligaments is to attach the menisci firmly to the tibia and to limit their excursions over the tibial articular surfaces.

The structure of the menisci is important in relation to the nature and resolution of meniscal injuries. They are composed of fibro-cartilage in which the fibres are arranged in bundles that run parallel to the outer border. The peripheral parts of the menisci are attached to the capsule and have a blood supply derived from it. These vessels penetrate for a short distance into the fibro-cartilage but leave the centres avascular. Meniscal tears following the direction of the fibres cut across the blood vessels and healing is much retarded in these cases, but where transverse tears extend from the peripheral border there is no interruption to the blood supply or to the healing processes. After surgical removal of the menisci in the dog and in some other species the menisci frequently regenerate from the region of the capsule.

The movements and functions of the menisci can be studied in fresh specimens from which the muscles have been removed to allow these structures to be seen. Due allowance should be made for the effects these muscles may have on the joint during life. From our studies of these preparations and from

PLATE I

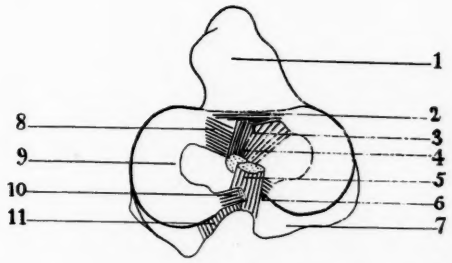
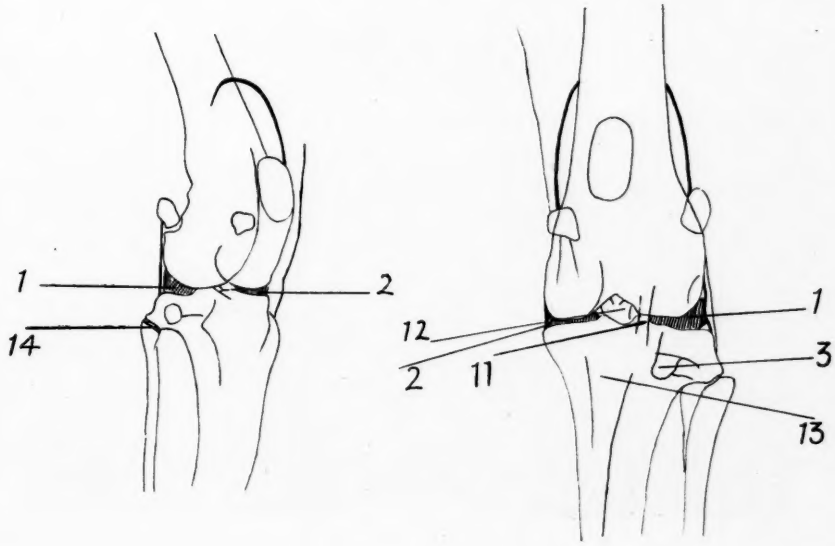


FIG. No. 1.

Proximal view of the upper extremity of the tibia with the menisci in the position of extension.

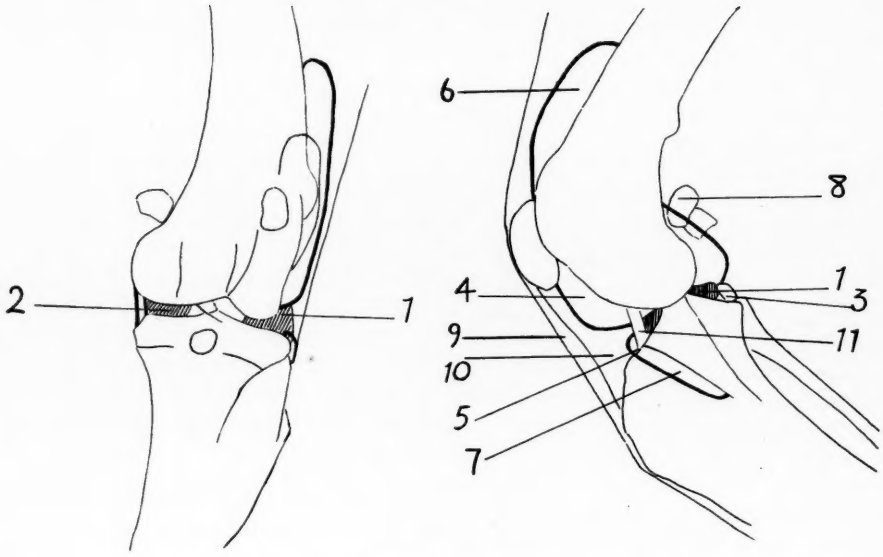
1—Tibial tuberosity. 2—Inter-meniscal ligament. 3, 6, 8, 10—Meniscal ligaments. 4—Anterior cruciate ligament. 5—Posterior cruciate ligament. 7—Articular Surface. 9—Lateral meniscus. 11—Lateral femoro-meniscal ligament.

DIAGRAMMATIC KEYS TO THE RADIOGRAPHS.



(Article by Dyce, Merlen and Wadsworth, page 346)

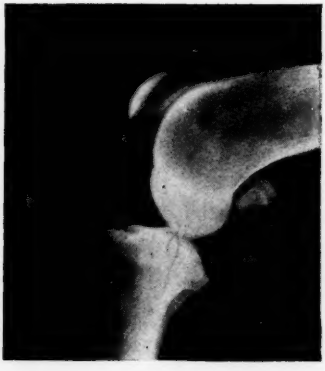
PLATE II



1—Lateral meniscus. 2—Medial meniscus. 3—Popliteal sesamoid bone. 4—Femoro-meniscal compartment of the joint. 5—Menisco-tibial compartment. 6—Supra-patellar diverticulum. 7—Extensor diverticulum. 8—Fabellæ. 9—Straight patellar ligament. 10—Infra-patellar fat pad. 11—Extensor tendons. 12—Cruciate ligaments. 13—Tibial crest. 14—Proximal tibio-fibular articulation.

RADIOGRAPHS 1-14.

I

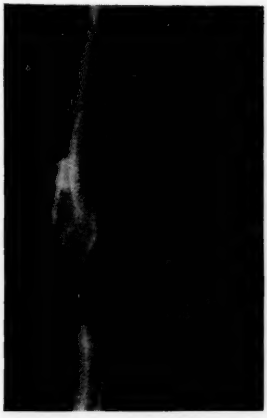


II

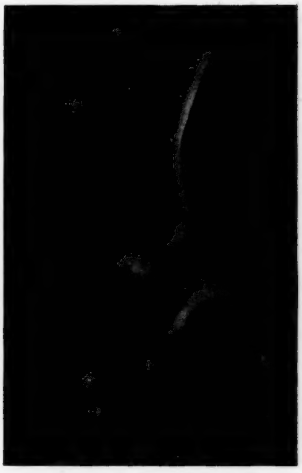
(Article by Dyce, Merlen and Wadsworth, page 346)

XUM

PLATE III



III



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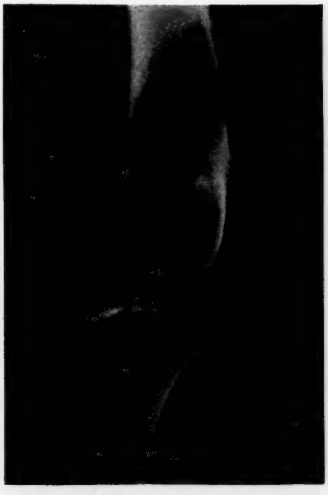

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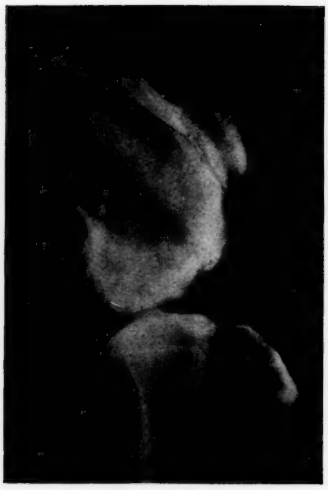
(Article by Dyce, Merlen and Wadsworth, page 346)

XUM

PLATE IV



IX

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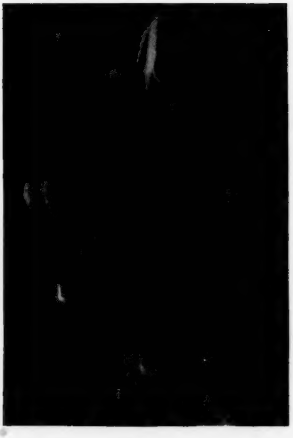
XI



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XII XIII

(Article by Dyce, Merlen and Wadsworth, page 346)

observations on normal dogs we find it difficult to believe that flexion and extension are associated with the rotation so often described in the literature, and we suspect that this has been inspired by comparison with the human joint. Rotation will, however, occur during abnormal movements.

At rest the menisci occupy the position which has already been described, and as the joint is extended they glide forward until in extreme extension they reach the anterior border of the articular surface of the tibia. Further progress is arrested by a wedging of the menisci between the femoral trochlea and the tibial condyles and by tension of the posterior cruciate and the femoro-meniscal ligaments. While the menisci glide over the tibial articular surface the condyles of the femur turn on the upper face of the menisci, and there is far more movement between the femur and the menisci than between the menisci and the tibia. In flexion the menisci glide backwards on the tibia but do not quite reach the posterior border of the condyles, and during further flexion the menisci and the tibia move as one until the posterior part of the femoral condyles is reached. The anterior horns are then found at the junction of the anterior and middle thirds of the tibial articular surface and maximum tension is now applied to the anterior cruciate, the two anterior meniscal, and the inter-meniscal ligaments. In life further flexion is prevented by the interposition of the muscle mass occupying the popliteal region, and over-flexion is far rarer than over-extension. As the menisci glide backwards and forwards on the tibial articular surfaces they describe arcs of ellipses, so that at rest the menisci are more widely separated than when in the positions of flexion and extension. At the same time, being elastic they are subject to a certain amount of distortion: in extreme flexion the anterior horns are stretched antero-posteriorly while the posterior horns are rounded; in extension the distortion is reversed and the anterior horns are rounded and the posterior horns are elongated.

While the joint describes these movements the cruciate ligaments twine around each other and also twist on themselves: they are less concerned, however, with limiting flexion and extension than with preventing forward and backward displacement of the femur on the tibia: the anterior cruciate ligament prevents the femur from being displaced posteriorly during extension, the posterior cruciate ligament prevents forward displacement during flexion.

The precise reason for the presence of the menisci has never been satisfactorily explained. The condyles of the femur and the head of the tibia are not congruent and it becomes necessary that some structure should be interposed to bring congruency about and to distribute the pressure more widely; on the other hand, this does not explain the incongruency in the first place. If the function is merely to deaden concussion it is surprising that similar cartilages are not found elsewhere and that the stifle can function so effectively after their removal. Nevertheless, the fact that they do regenerate after removal seems to show that they are a vital part of the articulation: the method of their regeneration—in two parts each associated with an articular surface—lends some support to McConnaill's theory that their function is connected with

the provision of additional surfaces over which the synovia can exert its lubricating function.

Having given an account of the normal movement and mechanics of the stifle joint, it is now necessary to direct attention to the methods by which injuries arise. It should be stressed that most cases of stifle lameness are not to be attributed to external trauma but to excessive and abnormal forces within the joint: these are brought about by rapid turns or by the lower limb becoming caught in some obstruction.

Considering first the effects of over-extension when uncomplicated by rotation, we have tension applied to the posterior meniscal ligaments—in particular to the femoral meniscal ligament—and to the posterior cruciate ligament, while the menisci are themselves stretched antero-posteriorly and are compressed in their anterior parts. Injury to any of these structures may result. When this situation is further complicated by inward rotation, additional strain is placed upon the same structures, especially upon the medial meniscus and its ligaments and upon the posterior cruciate ligament.

In extreme flexion great strain is placed upon the anterior meniscal ligaments and upon the anterior cruciate ligament, which together with the medial meniscus (the more posterior of the two) are liable to trauma. Should abrupt supination be imposed upon the limb, tearing of the medial meniscal and anterior cruciate ligament and of the medial meniscus itself may supervene; pronation may result in damage to the anterior lateral meniscal ligament, which is strained in this position.

These conclusions arrived at by the manipulation of fresh specimens are confirmed by a study of the extensive clinical literature and by the few clinical cases we have been able to examine. The entire literature confirms that the medial meniscus is much more vulnerable than the lateral one: a ratio of eight to one is a commonly quoted figure for the relative incidence of meniscal injury.

The Radiological Anatomy

As far as we have been able to determine, no radiographs of the normal stifle joint of the dog have been published and the clinician has therefore nothing with which he may compare his cases. This deficiency has been unfortunate as radiography of this region is frequently resorted to in the diagnosis of stifle derangements. It will be seen from the previous section that the structures most susceptible to injury are just those most difficult to demonstrate radiographically, and failure to appreciate this—together with faulty technique and inadequate anatomical knowledge—explains the frequent failure of radiography to assist in the making of a correct diagnosis. A satisfactory technique for the complete radiological examination of the stifle is complex, and this is discussed in an appended note.

The radiographs with the key outline tracings give a clearer conception of the radiological anatomy than can be obtained by lengthy descriptions: an examination of the radiographs will give sufficient indication of the situation and conformation of the main structures, and we shall therefore confine our remarks to emphasising a few of the more important features.

XUM

LATERAL VIEW (Radiographs 1 and 2)*

The presence and situation of the fabellæ and cyamella (or popliteal sesamoid) should be noted: absence of one or more of these sesamoids is not uncommon. The apparent size of the joint space is accounted for by the presence of the menisci. The position and extent of the femoro-tibial contact are to be noted. In the neutral position the axis of the articulation is more posterior than would be anticipated from a study of the intact limb. The tubercle projecting from the posterior aspect of the shaft of the femur (if present) is not to be considered an abnormality.

Radiograph No. 1 was obtained at 36 in., Radiograph No. 2 at 14 in.

ANTERIOR VIEW (Radiograph No. 3)

The features to be noted in this view are the angulation of the femur and the tibia and the unbalanced appearance of the joint space due to the medial position of the femur on the tibia. The radiograph illustrated was obtained with the animal restrained on its brisket. The patella is seen clearly since it is in close apposition to the casette. It will be noted that the lower extremity of the patella is not clearly defined and this should not be interpreted as bone erosion. It may be necessary to take other views of particular structures, and of these a tangential view of the patella and one of the intercondyloid fossa, obtained with the stifle flexed, are useful in appropriate cases.

Contrast Arthrography

The introduction of air into the joint allows the recognition of a number of structures invisible or not clearly delineated in the routine exposures (see the section on the technique).

LATERAL VIEW (Radiograph No. 4)

The extent of the joint capsule is clearly seen and the relationship of the infra-patellar pad of fat to the synovial capsule and the menisci is demonstrated. The division of the femoro-tibial joint cavity into femoro-meniscal and menisco-tibial compartments is well seen. The occurrence and extent of the supra-patellar and extensor diverticula are seen and explain the frequent incidence of joint infection following penetrating wounds some distance from the joint surface. The irregular outline of the tibial surface is a normal feature and the prominence of the irregularities varies with the accuracy of the positioning. A common shadow of the menisci may be observed together with the anterior cruciate ligament.

Radiograph No. 4 was taken at 14 in.

ANTERIOR VIEW (Radiographs Nos. 5 and 6)

The compartments of the joint are again seen together with the menisci: the lateral meniscus appears the larger. A composite shadow that may be partially differentiated is produced by the cruciates.

Radiographs Nos. 5 and 6 were taken at 14 in.

* The terms we employ to designate the views define the relationship of the part to the film, e.g., a lateral view is one in which the lateral aspect of the joint is nearest the plate and the rays penetrate the joint from medial to lateral; similarly, an antero-medial view is obtained when the antero-medial aspect is nearest the plate and the rays penetrate from the postero-lateral to the antero-medial aspect.

XUM

SPECIAL VIEWS (Radiographs Nos. 7 and 8)

Special views may be devised to demonstrate particular structures: for example, the medial meniscus is best seen in the antero-medial view (Radiograph No. 7, taken at 14 in.), and an antero-lateral view (Radiograph No. 8, taken at 36 in.) depicts the lateral meniscus and the proximal tibio-fibular articulation to the best advantage.

Radiograph No. 9 illustrates the result of a positive contrast technique.

Age Changes

In the young animal the articular cartilages are thicker and magnify the apparent size of the joint space: the epiphyses are separated from the bone shafts by thick plates of cartilages. It is important to bear these considerations in mind before arriving at a diagnosis of dislocation or avulsion. The epiphyses generally fuse with the shafts at about 10 months, but considerable variations occur depending on breed, environmental and individual characteristics. Radiographs Nos. 10 and 11 are of a Fox Terrier aged 14 weeks.

Radiographs Nos. 12 and 13 illustrate the joint in the positions of extreme normal flexion and extension.

Radiograph No. 14.—This arteriograph is included to demonstrate the vascular pattern of the stifle region.

A Note on the Radiological Technique

A number of factors combine to make the stifle a particularly difficult region to examine radiographically—the conformation of the part makes accurate positioning difficult, and the relative translucency to the X-rays of the important structures reduces the value of the normal technique. The use of a narcotic or short-acting anæsthetic is often advisable as it may be difficult to restrain the dog in the required position: if an injection is to be made, anæsthesia is essential.

In every radiological examination of the stifle joint the first procedure must be to obtain straightforward lateral and postero-anterior views to rule out the possibility of bone damage. These films should be studied before other radiographs are made. If doubt still exists as to the nature of the injury attention should be directed to the soft structures of the joint, and for this study the introduction of a contrast agent into the joint cavity is essential. We have used a number of proprietary contrast agents in attempts to outline the soft structures but we found these substances unsatisfactory as we had difficulty in securing dispersal of the agent throughout the various compartments of the joint cavity (see Radiograph No. 9). Moreover, these substances possess a radio-density sufficient to obscure the subjacent structures, when covering them in a thin film, and in this way small irregularities are easily concealed. A further disadvantage is that these substances possess a certain irritant action if not completely removed

from the joint cavity. We therefore concentrated on the use of air as a negative contrast agent. Air possesses certain advantages—it is always available and costs nothing, it disperses easily, it is translucent and non-irritant, and is in our opinion a thoroughly reliable contrast agent.

The technique of injection is simple. The most satisfactory method is a single injection into the supra-patellar pouch of the joint cavity. Filtered air is drawn into a sterile 20 c.c. syringe to which is attached a suitable hypodermic needle with a short bevel. The site is prepared in the usual way and the needle is introduced slightly above the upper limit of the patella about half an inch medial to the anterior midline of the limb downwards and inwards to pass between the patella and the femur. The quantity of air injected must obviously vary with the size of the dog, but in the greyhound about 12 c.c. is a suitable amount. The distribution of the air should be assisted by passive flexion and extension of the limb. Great care should be taken to avoid damage to the articular surfaces when introducing the needle: in our experience no unfortunate sequelæ have ensued from the adoption of this method.

An alternative procedure is to introduce the needle medial to the patellar ligament midway between its attachments. In this case it should be directed posteriorly and slightly proximally to pass through the infra-patellar pad of fat and into the medial femoro-meniscal compartment of the joint. It should be borne in mind in this instance that the space between the undilated joint capsule and the femoral condyle is small and it is very easy to insert the needle too far so that it impinges on the articular cartilage: should this mishap occur it is unlikely that complications will follow.

Preliminary examination of the inflated joint should again consist of anterior and lateral exposures. Further exposures of the views illustrated are often required.

In general we favour making exposures at an anode-film distance of 36 in.: this provides relatively undistorted general views. It is sometimes desirable to shorten the distance to 14 in., thereby securing greater enlargement and greater detail of the structures nearer the film by diffusing the image of overlying structures and at the expense of general distortion. Examples of exposures made at the two distances are included.

When making exposures to demonstrate soft structures it is necessary to employ a "softer" exposure technique than that suited for routine work.

The radiographs illustrated were obtained using a mobile X-ray unit and a Potter-Bucky couch. All the radiographs save Nos. 10 to 13 are of greyhounds.

Acknowledgments

We wish to thank Professor McCunn for the interest he has taken in this work and for giving us the benefit of his wide clinical experience.

Our thanks are also due to Mr. George Smith for providing us with material, and to Messrs. Bryant, Crosby and Levey for their technical assistance.

XUM

THE CONDITION AND BODY SIZE OF "WASTAGE" CATTLE

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University College, Aberystwyth

WASTAGE in dairy cattle and replacements in dairy herds have been examined by various investigators.[1, 2, 3, 4, 5, 6, 7, 8]

An investigation has been made concerning some recorded particulars of 47,888 cows and cow heifers purchased for slaughter by the Ministry of Food through the 25 Collecting Centres in West Wales during the four years 1943-46. This number represents annually about 8.6 per cent of the average cow population of the region or 34.4 per cent of the annual wastage assumed to be 25 per cent. Alternative methods of disposal are also available, such as the sale of barren cows to other areas for further fattening; the sale of in-calf and newly-calved cows and heifers for production elsewhere; whilst deaths and casualties account for 1 to 2 per cent of the cow population.[4, 9] The sale of surplus calves indicates that the cattle population of the region is dominantly Shorthorn,[10] although the Welsh Black, Friesian and Hereford breeds are popular in certain areas whilst more recently the Ayrshire has increased in numbers.

Cattle for slaughter are purchased in accordance with their condition and body size (or grade and weight), and the officials of the Ministry grade them into Special (S), A, B, C and the Rejects. This last group are ungraded animals which are not in a satisfactory condition to be purchased alive or on the hoof, but are bought on a dead weight basis. If after slaughter they are found unfit for human consumption, they are condemned. They are classified into Rejects, Casualties and Condemned. It was found that 65 per cent of the total cows were graded and 35 per cent ungraded, whilst only 9.2 per cent of the cow heifers were ungraded.

The following table gives the percentage grading, and the average live weight of each grade:—

TABLE I

Grade	Cows		Cow Heifers	
	Per cent grading	Average live weight (lb.)	Per cent grading	Average live weight (lb.)
S	10.4	1,101.4	1.6	1,102.1
A	13.8	1,201.0	14.8	1,057.3
B	42.1	1,108.0	62.8	968.7
C	33.7	1,047.5	20.8	887.7
Total ...	100.0	109.7	100.0	966.9

The following table gives the classification and average dead weight of the ungraded animals:—

TABLE II

Class	Cows		Cow Heifers	
	Per cent	Average dead weight (lb.)	Per cent	Average dead weight (lb.)
Rejects	65.0	404.9	36.7	339.6
Casualties ...	12.6	447.5	58.5	414.1
Condemned ...	22.4	—	4.8	—
Total ...	100.0	—	100.0	—

In this region the total condemned meat amounts to 80 lb. per ungraded animal. At the present time cows represent about 45 per cent of the animals slaughtered for beef in this country. Therefore a considerable increase in beef supplies would be obtained if it were possible to improve the condition and weight of the lower grade animals. The above totals indicate that more than 50 per cent of the wastage cows are in Grade C and Rejects. The cow heifers comprise 9.6 per cent of the total and the peak sales occur during the autumn months.

This investigation has also provided evidence that certain areas in this region produce cows of a range in live weight within each grade. The western coastal areas produce body fat on relatively small frames; the eastern foothills grow large-framed cows in a lean condition; while the dairying areas of the central parts supply cows of significantly lighter weights.

It appears that variations in climatic conditions within the region can account for differences in the condition and body size of wastage cattle largely by their effects on the nutritive values of the food supplies and on the peak period of calvings.

A more comprehensive paper on this material is being prepared for publication.

Acknowledgment is made to the Ministry of Food (Livestock Branch) and to Major John Francis, Carmarthen (Chairman of Auctioneers), for facilities to examine the records; and to Messrs. Copper, Robertson and McDougall (Scientific Branch), for financial assistance in connection with this investigation.

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NEWS

MESSRS. W. WATSON & SONS LTD. inform us that they are holding an exhibition, "The Microscope in Industry and Research," at the New Horticultural Hall, Westminster, from September 15 to 19, 1952. Hours on the first day, September 15, will be 2 p.m. to 6 p.m.; on September 16, 17 and 18, 10 a.m. to 6 p.m; and on the last day, September 19, 10 a.m. to 4 p.m.

They will be displaying an extensive range of microscopes, illustrating the part they play both in industry and research. The specimens to be shown on the microscopes will all be provided by users of their instruments and will cover a very extensive range in industrial and research fields. They are preparing a small brochure which will give details of the various techniques to be displayed, and will be pleased to send one to any veterinary surgeon applying to them at 313, High Holborn, London, W.C.1.

A SERIOUS fire in which the whole of the basic production department was completely gutted occurred in the early morning of July 17 at the Crookes Pharmaceutical Laboratories which cover two acres in Gorst Park, Park Royal, London.

The fire was discovered by the night-watchman and is believed to have been caused by a cable fault.

Pharmaceutical machinery including filling equipment, vats, tanks and basins was damaged.

Mr. G. E. Watson, general manager, said: "Fortunately there were no casualties, and although half the production section which makes pharmaceutical products has been wiped out, our production of fish liver oils was quite unaffected. Thanks to the foresight in the duplication of departments the supplies position generally will not be affected."

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